TER and RELATED LAND RESOURCES 3529
UMBOLDT RIVER BASIN
NEVADA

REPORT NUMBER TEN

SONOMA SUB - BASIN

MAY 1965

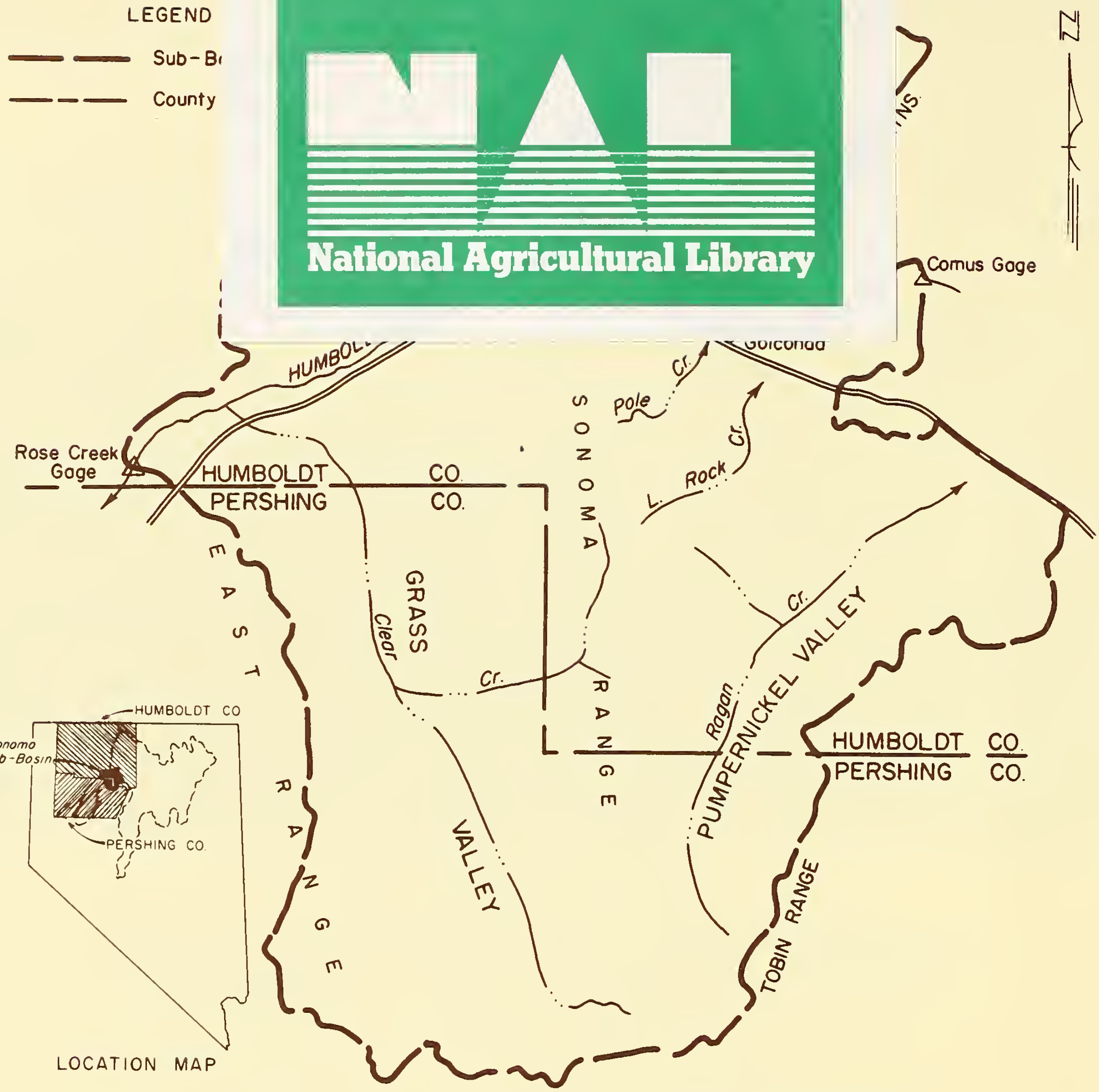
Based on a Cooperative Survey

by

THE NEVADA DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES
and THE UNITED STATES DEPARTMENT OF AGRICULTURE

Prepared by

Economic Research Service · Forest Service · Soil Conservation Service



SONOMA SUB-BASIN

HUMBOLDT RIVER BASIN SURVEY

HUMBOLDT & PERSHING COUNTIES, NEVADA

MAY 1965

4 0 4 8 12
SCALE IN MILES

COVER PHOTO

In a striking example of the mountain watershed-valley town relationship, this photograph depicts Winnemucca, Nevada, one of the Humboldt Basin's most important towns, as seen from the slopes of Winnemucca Mountain. The snow-capped Sonoma Range, formerly one of Winnemucca's principal water-supply sources, and in its present condition a potential flood-producer, is seen in the background. FIELD PARTY PHOTO

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REGISTER

REPORT NUMBER TEN

SONOMA SUB-BASIN

MAY 1965

Will you please detach and fill out this form; mail it to us, so that we may send you any additions, changes, or corrections.

Central Lahontan Basin Field Party
Box 228
Carson City, Nevada 89701

Name ______________________________

Address ______________________________

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WATER AND RELATED LAND RESOURCES

REPORT NUMBER TEN

HUMBOLDT RIVER BASIN

NEVADA

SONOMA SUB-BASIN

Based on a Cooperative Survey
by
The Nevada Department of Conservation and Natural Resources
and
The United States Department of Agriculture

Forest Service - Soil Conservation Service
Economic Research Service

May 1965

FOREWORD

This is a report for the people of Nevada, and particularly for the people of the Humboldt River Basin, concerning water and related land resources in the Sonoma Sub-Basin. It is the tenth of a series of reports resulting from a cooperative survey of the Humboldt River Basin by the Nevada State Department of Conservation and Natural Resources and the U. S. Department of Agriculture. It was prepared by the Soil Conservation Service, Forest Service and the Economic Research Service of the Department of Agriculture.

The State of Nevada seeks constantly to assist local people and their organizations in the conservation, development and management of water resources. It has particular regard for the relationship of water to land and to human resources. This is exemplified by the creation of the Nevada State Department of Conservation and Natural Resources. A primary responsibility of that Department is to cooperate with Federal agencies and local groups and to coordinate State-Federal activities that help solve water and related land problems for the people of Nevada.

The responsibilities of the Nevada State Department of Conservation and Natural Resources, and the cooperative research work already under way in the Humboldt River, set the stage for Federal-State cooperation in developing information on opportunities for improving the use of the land and water resources of the Basin. Accordingly, cooperation was initiated with the U. S. Department of Agriculture under a Plan of Work dated June 3, 1960 with agencies of the Department and of the State of Nevada participating in the survey. It is important here to point out that responsibility for matters concerning State water rights and determination of water supply as it might affect State water rights was assumed by the State of Nevada.

This cooperative survey of the Humboldt River Basin is for the primary purpose of determining where improvements in the use of water and related land resources, some of which have social and economic aspects, might be made with the assistance of projects and programs of the U. S. Department of Agriculture. A major part of the survey is focused on situations where improvement might be brought about by means of Federal-State-local cooperative projects developed under the Watershed Protection and Flood Prevention Act (Public Law 566, 83d Congress as amended). This survey is in keeping with long-established tradition in the Department of Agriculture of cooperation with States and local entities in the conduct of its work. Further, such cooperation is a most important responsibility of the Nevada State Department of Conservation and Natural Resources.

The U. S. Department of Agriculture-State of Nevada Plan of Work in the Humboldt River Basin offers opportunities for participating in the survey by other Nevada State agencies and Federal agencies. The Bureau of Land Management, as an example, has cooperated with respect to the public domain. Thus, the survey is not limited, but is, rather, as broad in scope and agency participation as is required to meet the agreed-upon objectives.

The entire Humboldt River Basin is being studied by segments identified as sub-basins. This report contains much information for study and use in understanding and solving some of the existing water and land resource problems in the Sonoma Sub-Basin. The report revealed that there is one opportunity for a Federal-State-local project-type development under the present interpretations of the Watershed Protection and Flood Prevention Act.

I wish to recognize the excellent work of the U. S. Department of Agriculture and the State Department of Conservation and Natural Resources in this cooperative effort. I consider that this report will serve the best interest of the people in the Humboldt River Basin and the State of Nevada.

Grant Sawyer

Governor of Nevada

HUMBOLDT RIVER BASIN SURVEY

SONOMA SUB-BASIN REPORT

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ORGANIZATION OF REPORT

The report on the Sonoma Sub-Basin is divided into three main sections. The first section is an overall report on the sub-basin; the remaining two sections consist of Appendix I and Appendix II, respectively.

Appendix I is attached to all the report copies, and contains pertinent textual matter concerning the sub-basin which is of value to the general reader.

Appendix II is produced in a relatively limited number of copies. Its small appeal to the general reader renders it unsuitable for inclusion with the report copies for general distribution. However, this type of material does have potential value as an information reservoir for technicians, administrators, and resource managers concerned with the Sonoma Sub-Basin. Copies of this appendix are available upon request.

SUMMARY

The Sonoma Sub-Basin is in the west-central part of the Humboldt Basin. Most of the area extends south from the Humboldt River in the vicinity of Winnemucca, but it includes the short drainages north of the river, as well as the Humboldt bottomland between Comus and Rose Creek gaging stations. Pumpernickel Valley, which drains into the Humboldt above Comus, is also included. The area lies in two counties, Humboldt and Pershing, and contains approximately 754,000 acres.

The history of exploitation of the sub-basin's resources extends from the fur-trading period (1828), through the emigration and mining periods, to the present ranching industry.

Settlement of the present site of Winnemucca by whites started in 1861. The establishment of a community at this site in 1863 is credited to three Frenchmen, Frank Baud, Louis and Theophile Lay, and an Italian, Joseph Ginaca. They built a toll bridge across the Humboldt and a store. The settlement was first known as Frenchman's Ford, French Bridge, or Ginaca Bridge, and during the latter part of the wagon train emigration period it was one of the principal rest stops and supply centers along the Humboldt. With the arrival of the Central Pacific Railroad in September 1868, Winnemucca began to assume its present important status as a transportation hub for southwest Idaho and Central Nevada points.

Golconda was settled about the same time as Winnemucca, as a by-product of the Ginaca-Gintz Humboldt Canal. The town later became the headquarters for the Golconda & Western Exploration Company, Ltd. It boasted 500 inhabitants at the height of the mining boom, in 1899.

Big sagebrush-grass and shadscale-grass are the predominant vegetal cover over most of the sub-basin. Big sagebrush grows as fringes along the Humboldt bottomland, on the upland benches and terraces, and on the steep mountain slopes. Associated with the sagebrush in the higher elevations are such shrubs as serviceberry, tall rabbitbrush, rock-spirea, and desert peach. The grass understory includes cheatgrass, Sandberg bluegrass, Great Basin wildrye, needle-and-thread grass, and bluebunch wheatgrass.

Shadscale occupies the flatter slopes of the uplands and alluvial fans in association with bud sagebrush, bottlebrush squirreltail, Sandberg bluegrass, and cheatgrass.

Black greasewood is the dominant cover throughout the bottomlands of Grass Valley and the northern half of Pumpernickel Valley. Rubber rabbitbrush and Great Basin wildrye occupy the bottomland of the Humboldt River, along with saltgrass, alkali sacaton, and willow stringers.

Utah juniper is thinly scattered on the Sonoma and East Ranges. These trees are stunted and poorly formed, and have little commercial value. Other trees and large shrubs include cottonwood, chokecherry, and aspen, which are found as stringers along creek bottoms and as groves and clumps on the north slopes of the Sonoma Range.

Most of the rangelands are producing far below their potential. In some areas, such as the Clear Creek drainage, deterioration is so severe that even prolonged protection and extensive restoration practices will not bring this watershed back to where it will be suitable for livestock use.

Of the 741,000 acres of range land, approximately 681,800 acres are currently in the low forage production class, 48,600 in the medium class, and 10,600 are in the fairly high forage production class.

The raising of livestock, mostly cattle, is the dominant agricultural enterprise. The privately owned lands, estimated at 39 percent of the total sub-basin acreage, are used for the production of irrigated crops and range forage. The public domain (national land reserve), estimated at 61 percent, is used primarily for spring-fall and summer range for livestock, and as habitat for big game and other wildlife.

Livestock numbers on ranches in the sub-basin in 1963 were estimated at 20,000 cattle and 4,000 sheep, based upon Bureau of Land Management records of issued licenses. The sheep industry has been decreasing in importance over the past 30 years. At present there are no operations with sheep-raising as their principal enterprise, and only three major operators have combined sheep and cattle. The number of cattle and calves on ranches approximately doubled from 1939 to 1959. This was partially the result of ranchers shifting from sheep to cattle enterprises. There are an estimated 10,000 head of cattle and calves and 3,000 sheep and lambs produced and shipped from the sub-basin annually. California packers and feeders receive about 50 percent of the cattle shipped, and Idaho buyers receive about 20 percent. The other 30 percent either remain in Nevada or are shipped to other western States.

Climate in the sub-basin is arid, with most of the moisture falling as snow during the winter months. The average annual precipitation varies from six inches in the lowlands to 25 inches in the Sonoma Range. The average frost-free period (28 degrees F) for the irrigated land along the Humboldt River is estimated to be 140 days.

Surface water which originates within the sub-basin and flows to the Humboldt is negligible, except during abnormal conditions. Most of the water yield is either used by irrigated crops or phreatophytic plants, or goes into ground water storage. A study of the subsurface flow is beyond the scope of this report. The U.S. Geological Survey estimated that from 11,000 to 14,000 acre-feet of subsurface water flow into the Humboldt annually; Grass Valley 5,000 to 6,000, Little Humboldt drainage 3,000 to 3,500, Pole-Little Rock Creek area 3,000 to 4,000, and in the Humboldt, 350 to 700 under the Comus gage.

The annual water balance studies, which were made for an 80 percent frequency (chance) flow year, indicate that 15,000 acre-feet are used to produce hay or pasture on 13,000 acres of cropland, 23,000 acre-feet are used by phreatophytes of all classes on 57,000 acres, 4,500 acre-feet evaporate from surface water, and 500 acre-feet are used by the City of Winnemucca. An estimated 3,300 acre-feet of water are pumped from ground water storage to irrigate 2,300 acres of alfalfa and grain in Grass Valley. It is questionable whether this withdrawal from ground water storage is being replenished by the average annual yield.

There are about 16,900 acres of land along the Humboldt with decreed water rights in the sub-basin. There is additional acreage along the river and in tributary drainages with permitted or vested rights. Currently, there are an estimated 13,000 acres of cropland, of which 2,900 acres are in alfalfa, 600 acres in grain, and 9,500 acres in meadow hay and pasture. There are an additional 5,000 acres of pasture land which are flooded during years with above-normal streamflow. All of the land planted to alfalfa or grain has been either leveled or smoothed. Other improved irrigation developments which have been installed consist of pipelines, concrete ditch lining, overnight storage reservoirs, spring developments, and water wells. Although these improvements are a step in

the right direction, considerably more are needed if the crop yields are to be increased and efficient water use is to be attained.

HUMBOLDT RIVER BASIN SURVEY

SONOMA SUB-BASIN REPORT

AUTHORITY AND ORGANIZATION

The need for continually improving the conservation and use of water and related land resources has long been recognized by Federal, State, and local agencies. A pertinent development of this continuing interest is River Basin studies under Section 6 of Public Law 566, as amended and supplemented. In Nevada such a survey is underway by the U.S. Department of Agriculture and the Nevada State Department of Conservation and Natural Resources.

The Secretary of Agriculture is authorized under the provisions of Section 6 of the Watershed Protection and Flood Prevention Act to cooperate with other Federal and with State and local agencies in making investigations and surveys of the watersheds of rivers and other waterways as a basis for the development of coordinated programs.

General direction for the U.S. Department of Agriculture in the conduct of the studies and preparation of the report was provided by a USDA Field Advisory Committee composed of representatives of the Soil Conservation Service, Forest Service, and Economic Research Service. The USDA River Basin Representative served as advisor and consultant to the committee.

General direction for the State of Nevada was provided by the Director of the State Department of Conservation and Natural Resources.

A Field Party, composed of representatives of the Soil Conservation Service, Forest Service, and Economic Research Service completed the field work and prepared this report.

Grateful acknowledgement is made to all individuals and to the personnel of other State and Federal agencies who gave their counsel and technical assistance in the preparation of this report.

HISTORICAL INFORMATION

Settlement

Peter Skene Ogden and his Hudson's Bay Company Snake Country Brigade were the first white men to enter the Sonoma Sub-Basin, in November 1828. On this, the fifth of his Snake Country Expeditions, Ogden was adhering to his company's "scorched earth" policy. This policy had a three-fold objective: (1) to combat the American fur trappers on their home grounds, including the Great Basin, instead of the Company's lands farther north; (2) deplete the Snake and the Great Basin areas of their fur resource, before the final settlement of the boundary line between the United States and Canada made these areas "off limits" to the Hudson's Bay Company; (3) relieve for awhile the trapping pressure on the Company's own trapped-out holdings in western Canada.

Ogden entered the sub-basin and struck the Humboldt River on November 9, by way of the Little Humboldt. At this point he found the Humboldt lined with willows, and well-stocked with beaver. Accordingly, he explored its course westward for three days, until near present Mill City on November 12 he decided to turn back and travel eastward

Photograph 1. - South of Winnemucca, the California Emigrant Trail ruts still twist their way through the sand dunes along the west bank of the Humboldt River. The view here is southward, with the Eugene Mountains looming in the far distance.
FIELD PARTY PHOTO 6-852-12

Photograph 2. - Bridge Street bridge over the Humboldt River at Winnemucca, looking upstream from the U.S. Highway 95 bridge. This concrete arch bridge, which late in 1910 replaced the iron bridge across the Humboldt River damaged in the wet-mantle flood of 1910, is located at the site of the original toll structure built by Ginaca, Baud, and the Lay brothers on the California Emigrant Trail ford over the Humboldt in 1863. The town of Ginaca Bridge (French Bridge) consequently grew up at the south bridge approach (right side of photograph). It was renamed Winnemucca in 1866. FIELD PARTY PHOTO

up the river toward his planned winter camp at Ogden's Hole (Huntsville) Utah. He gave the name "Unknown River" to the Humboldt at this time, as he was by now unsure where it went.

On the return trip from present Utah the following spring, Ogden and his trappers reached present Winnemucca on May 10 by way of the Little Humboldt. Ogden then proceeded down the Humboldt to the Humboldt Sink, reaching there on May 29. After retracing his route to the Little Humboldt, he left the Humboldt Basin by way of Paradise Hill Pass on June 11.

One additional large trapping expedition was mounted by the British on the Humboldt in the spring and early summer of 1831. The Snake Country Brigade, then under the command of John Work, traveled down the middle reaches of the Humboldt from Beowawe to the vicinity of Iron Point, where the trappers cut directly north across to the Little Humboldt, and so out of the sub-basin.

The Bonneville-Walker party of American fur trappers along the Humboldt in 1833-1834 brought the era of large-scale fur exploitation here to an end. This group is of particular interest because Joseph Walker, the guide, realized the potentialities of the Humboldt River as an access corridor for travel to and from California. He was to put his knowledge to good use nine years later, in 1843, when he guided the Walker-Chiles Party along his 1834 return route to the Bear River rendezvous with Captain Bonneville.

The California emigration period of wagon travel along the Humboldt lasted for approximately three decades, 1841-1870. It opened with the advent of the Bidwell-Bartleson Party (mounted) which traversed the Humboldt main stem through this sub-basin in late September and early October 1841. Wagon travel along the California Emigrant Trail continued until well up into the 1870's. (See photograph 1.)

It was during the latter part of the emigrant period that the present site of Winnemucca was settled by whites (1861). However, the establishment of what is now Winnemucca is credited to three Frenchmen and an Italian: Frank Baud, Louis and Theophile Lay, and Joseph Ginaca. The Frenchmen came from France to California in 1851, and in 1862 came to Nevada Territory to work on Joseph Ginaca's and Dr. A. Gintz's ambitious but abortive Humboldt Canal project. In 1863 Baud, the Lays, and Ginaca built a toll bridge (site of present Bridge Street bridge) where the emigrant trail crossed from the south to the north banks of the Humboldt River (see photograph 2). Frank Baud erected a store on the south bank (now part of the Winnemucca Hotel), became the first postmaster, and before his death in June 1868, left money for the second school in the settlement, erected in 1869, portions of which are still standing. The settlement became known as Frenchman's Ford, Ginaca Bridge, or French Bridge, the name most commonly used, and during the period from 1863 to the close of the wagon train emigration period was the principal emigrant rest stop and supply center on the Humboldt between Humboldt Wells and Big Meadows. On February 1, 1866, a post office was established here, and named Winnemucca, after the famous Paiute chieftan.

The Central Pacific rails from the west reached Winnemucca by noon of September 16, 1868, and the railroad was formally opened for business to that point on October 1. By the latter date the track-layers had reached and passed Iron Point, on the Sonoma Sub-Basin's eastern boundary. A stage and freight toll road was immediately opened from Winnemucca to the new silver strikes in Idaho Territory, at Silver City and Boise City.

Over this road William (Hill) Beachey, periodically moving the western terminus of his railroad stage lines eastward with the advancing Central Pacific railhead, began

running a daily line of mail and passenger stages from Winnemucca, his new terminal, and continued to do so until May 1870, when he abandoned the Winnemucca-Silver City-Boise route in favor of the new Elko-Cope-Boise route. However, in June 1873 Northwestern Stage Lines - the giant combine which in October 1870 had taken over Beachey's Railroad Stage Lines in Nevada and Idaho and John Hailey's stages in southern Idaho - re-established the Boise-Winnemucca route.

By 1875 Winnemucca was the hub of stage and freight roads radiating not only to Idaho points, but also to Unionville, Humboldt City, Star City, and Dun Glen, to the south and west, and Paradise City, Spring City, and Queen City in Paradise Valley. Also, through the establishment in May 1873 of a freight road through Grass, Pleasant and Jersey Valleys and the Home Station Gap to Antelope Valley on the Reese River drainage, Winnemucca had become competitive with Battle Mountain in freighting to Austin and the upper Reese River mines. Through the years, because of its strategic location, it has continued to be a staging point and transportation center. During the period from the late 1870's to the 1890's, Winnemucca was the shipping point to California for enormous herds of cattle from the huge northern Nevada and southern Oregon cattle baronies of Miller & Lux, Peter French, and Stauffer & Sweetser. During this period, Winnemucca's function as a cattle shipping point transcended its other activities.

In 1869, Winnemucca, flexing its muscles, felt big enough to challenge Unionville, the first Humboldt County seat, for that important designation. Unionville, bypassed by the Central Pacific in 1868 because of its remote location, and on the downgrade as a mining camp, by 1873 had passed its prime. However, it was only after a four-year, hard-fought struggle, 1869-1873, that Winnemucca succeeded in capturing the prize. Since 1873 Winnemucca has continued as the seat of the county government.

A second railroad, the Western Pacific, which was the last of the transcontinentals, built through Winnemucca in April 1909. Winnemucca was selected as a freight and passenger division point on the new line, which designation it still holds.

The Golconda area of the sub-basin was settled and developed concomitantly with Winnemucca; both were by-products of the previously mentioned Ginaca-Gintz Humboldt Canal. The canal was projected by these two men in 1862, to take the water of the Humboldt at Preble, immediately west of Iron Point, and carry it 60 miles through the fertile Humboldt bottomlands from Golconda to Mill City. It was planned that Mill City would become the ore-reduction and shipping point for the bustling mining camps at Unionville, Humboldt City, Dun Glen, and Star City. Enroute from Preble, the canal's water would be used to irrigate all the agricultural lands below it, and it could even be used for a barge transportation system.

After the expenditure of over $100,000, largely French capital, and several years labor, the canal had been built to Winnemucca, a distance of 28 miles. Here progress stopped; because of poor engineering, there was insufficient drop to develop a head of water adequate to the projected needs. However, the canal continued to be used for irrigation until about 1870, when it was finally abandoned. Several remnants are yet visible from Interstate 80 (U.S. Highway 40) in the Golconda vicinity.

If the "Old French Canal", as it was often called, was a failure in one sense, however, it was very successful in another. It brought into the Winnemucca-Golconda country a group of enterprising young Frenchman, who were quick to sieze upon the area's development possibilities. Among them were the brothers Louis and Theophile Lay, Frank Baud, and Louis Dutertre, all of whom had come to California from France in 1851.

In 1862 the Lays came to work on the canal as sub-contractors, bringing with them Frank Baud. The part of these three men in the founding and early development of Winnemucca has already been detailed. The Lay brothers and Louis Dutertre acquired agricultural lands in the Golconda Valley to be irrigated from the Humboldt Canal, and Dutertre in the 1890's developed the Golconda Hot Springs. Here he built a large hotel and resort, which soon became well known and patronized as a spa and health center. To furnish additional culinary and irrigation water for his ranch and town property, Dutertre built two 80-acre reservoirs on Pole Creek. The breaking of the larger reservoir dam on the morning of May 28, 1906 precipitated one of Humboldt County's greatest disasters to that time (see <u>Flood Damage</u>). The old hotel continued to be used until it burned down in 1961.

The largest and most important mining activity in the sub-basin did not begin until 1897. This development took place in the Adelaide (Gold Run) district, 11 miles south of Golconda, where mining had been carried on in a desultory manner since 1866, the year the Gold Run district was organized.

Thirty years of off-and-on mining activity, in which copper played a very minor part, was merely setting the stage for the period of intense and hectic operations which were to ensue from 1897 to 1900, and again from 1907 to 1910. This spurt of furious energy stemmed from the acquisition of the old Adelaide copper workings in April 1897 by the Glasgow & Western Exploration Company, Ltd., a Scotch Company which included members of the famous Coats thread manufacturing family.

A townsite was laid out at Golconda, surrounding Dutertre's Golconda Hot Springs buildings, constructed only a year or two previously. To process the Adelaide copper ores, a massive reduction mill and smelter were constructed at a cost of approximately $250,000 on the lower slopes of Edna Mountain, east of town.

Grading on a 12-mile narrow-gage (three feet) railroad, appropriately named the Golconda & Adelaide, was started from the Central Pacific main line at the new Golconda mill site in October 1897, and shortly completed to Adelaide. The line commenced hauling copper ore, mine timbers and supplies between Golconda and Adelaide in January 1898.

The year 1899 marked the height of Golconda's boom. The town boasted 500 inhabitants, with six hotels, a newspaper, several stores, many bars, a racetrack, and a flourishing tenderloin district.

The Golconda boom was short-lived. By 1900, because of difficulties in treating the Adelaide and Copper Canyon ores, the mine, mill and railroad were shut down. Everything remained quiet until 1907, when the Golconda concentrating plant and smelter were remodeled, and full-scale operation of the whole Golconda-Adelaide complex was resumed. This time operations were continued until 1910, when the Scotch company finally gave up; it was liquidated in 1913.

The Adelaide mines were purchased by the Yerington Mountain Copper Company (now Anaconda) in 1916, but little additional mining was done by this concern before it abandoned operations. Francis Church Lincoln states that up to 1920, a total of almost $350,000 worth of copper, gold, silver, lead and zinc was produced. Not much additional dollar value has been added since that time, although sporadic mining activity has continued over the years.

Except during the period when it was eclipsed by the shipment of livestock from

northern Nevada and southern Oregon, as previously mentioned, livestock raising has always been the sub-basin's most important activity. Such operations here, however, have generally been on a somewhat smaller scale than those in the Battle Mountain Sub-Basin and the sub-basins above Palisade.

Among the earliest larger cattle operations were those of I. V. Button, who ranged from north of Button Point toward Paradise Valley and the Little Humboldt. According to Doris Cavanagh, chronicler of past events and activities in and around Winnemucca, Button had very little land on the Humboldt itself, however. His brands were among the first registered in Humboldt County (1873). The Button Ranches are now part of the Ellison Ranching Company holdings.

Ottman Reil operated a cattle spread below the Buttons, along the Humboldt near the mouth of the Little Humboldt. His O R brand was first registered at Winnemucca in 1876. The old Reil ranch subsequently passed through several ownerships, including Stauffer & Sweetser, and Henry F. Howison of California. The latter sold it to the present owner, Baer Ranch, Inc., in December 1960.

Cattleman George D. Bliss had large holdings between Golconda and Valmy, as did the Bains, George A. and his sons, George H. and Leroy A. Bain. George H. Bain's ranch lands were at Iron Point (Comus), while the other Bains had ranges on lower Little Rock Creek and Pole Creek. The first Bliss brand was registered at Winnemucca in 1884, as was George A. Bain's.

George D. Bliss' C S Ranch at Button Point, west of the Diamond S, absorbed the original 160-acre Golconda Cattle Company lands of the Lay Brothers, which were irrigated by the old French Canal. In March 1946 George Bliss and Richard O. Bliss sold the C S and the famous Bullhead Ranch on the Little Humboldt, which they had previously acquired, to Walter W. Akers.

In May 1947 Akers sold both these ranches to Norman Biltz, Edward Watts, George Hart, and Henry F. Bennett, all of Reno, operating under the corporate title of Bullhead Cattle Company. In December 1960, this company sold the old C S and Bullhead spreads to Jacob Schneider, who held them until June 1964, when he disposed of them to Nevada Garvey, Inc. (Willard W. Garvey).

The Diamond S, another well-known cattle ranch in the sub-basin, was first owned in approximately its present size in the early 1900's by the Stall brothers. To improve irrigation on the ranch, they constructed the Stall dam across the Humboldt at the site of the old French diversion dam. From the Stalls, the ranch passed through several ownerships, including the C. &. P. Company and S. F. Friedman (April 1945). On June 30, 1946, Friedman sold to a group of Chinese, who gave the ranch its Diamond S name. They supplemented the Stall irrigation improvements by partially reconstructing the old Dutertre Reservoir on Pole Creek, washed out in the disastrous dry-mantle flood of May 1906, and in addition to raising cattle, began a truck-gardening operation on the ranch. The Chinese sold to the Holland Livestock Company in the 1950's. This company operated the ranch until November 27, 1962, when it was acquired by Frank McCleary, who held it only until January 10, 1963.

At that time McCleary sold the Diamond S, along with his Paradise Valley Ranch, to Nevada Garvey, Inc. Then, as previously detailed, in June 1964 Nevada Garvey acquired the Schneider group of ranches (Bullhead, C S).

Miller & Lux, the large California cattle company who in the period 1880 to the

early 1900's operated ranches in western Nevada, California, southern Oregon, and Quinn River in northern Nevada, acquired range lands at the west edge of Winnemucca in the 1880's. These lands were used primarily as pastures and holding grounds for the enormous numbers of cattle driven in from the Miller & Lux (Pacific Livestock Company) ranches to the north every fall, before the livestock were shipped to the Los Banos, California headquarters ranch. This old Miller & Lux property is now owned by Frank Garteiz.

The sheep industry in the sub-basin, now of relatively minor significance, was much more important in the period from 1890 to the passage of the Taylor Grazing Act, in 1934. The Humboldt Star at Winnemucca in 1914 spoke of the "countless thousands" of migrant sheep which had, within recent years, passed through Grass Valley, enroute to and from their summer ranges in the Sonoma, Santa Rosa, the East Range, Humboldt Range, and others. This, according to the newspaper, had led to the trampling out or overuse of the once verdant ryegrass meadows in Grass Valley, to the point where only a few scattered meadows were left. The high summer ranges in the aforementioned mountains, particularly in the Sonoma and Santa Rosa Ranges, were treated particularly harshly by transient sheep operators. Many of the disastrous floods and the resultant terrific watershed damage evident in the high mountains in this part of the Humboldt Basin can be ascribed to this past range and watershed abuse.

In 1913 the first primitive automobile road through the sub-basin followed portions of the old emigrant wagon route and the Woodward & Chorpenning (1851-1854 and 1857-1859) mule-mail, express and stage route. In 1917 this automobile road became known as U.S. Route 1 in Nevada, and in 1919-1920 was designated as the Victory Highway.

In 1925, following the nation-wide change of highway names to numbers, the Victory Highway became U.S. Highway 40; it was paved in the 1930's. Further location and improvement work followed in 1941-1942, and in 1960-1961 the first section of Interstate 80 in the sub-basin was completed east from Golconda over Golconda Summit. Many sections of U.S. Highway 40 in the sub-basin are scheduled for reconstruction to Interstate 80 standards in the near future, with a section through downtown Winnemucca being relocated.

The first organized effort toward the conservation and management of the soil, vegetal, and water resources of the sub-basin began in 1935. At that time, under the provisions of the Taylor Grazing Act, the Winnemucca Grazing District was established, and administered by the Division of Grazing - now the Bureau of Land Management, Department of the Interior - to manage the public domain (national land reserve) lands.

Two soil conservation districts, Sonoma and Paradise Valley, operate in the sub-basin, and provide assistance to ranch operators in the conservation and development of the soil, water, and range resources on privately owned lands. The Sonoma district was organized in February 1954, and the Paradise Valley district in February 1946.

Floods

The Sonoma Sub-Basin has been subjected to recurrent periods of flooding and high water. The earliest recorded flood year along the Humboldt main stem was December 1861-January 1862. However, since this flood was just prior to the earliest period of settlement in the middle reaches of the Humboldt Basin, there are no known records of damage.

For further information on the history of floods and high water periods in the

sub-basin, the reader is referred to the section on flood damage.

Fires

The Sonoma Sub-Basin has suffered several disastrous range and watershed fires since May 1958, the date of the 2,120-acre fire on Winnemucca Mountain. This has been the largest and most destructive fire to date in the Sonoma Sub-Basin, although the 1,500-acre Rose Creek Fire in late June 1958 and the 300-acre Pedroli fire in July 1946, both man-caused, also resulted in the destruction of valuable range and watershed vegetal cover. (See photograph 20.)

The 5,500-acre Raspberry Fire of late July 1963, which has resulted in the development of a severe wind erosion area along U.S. 40 west of Rose Creek, had only about one-fourth its acreage in this sub-basin. The remainder lies in the adjacent Lovelock Sub-Basin.

PREVIOUS STUDIES

The Winnemucca reach of the Humboldt River between Comus and Rose Creek gaging stations has been and is presently being studied by a number of cooperating Federal and State agencies as part of a research project. The project was set up as a means to develop data and techniques needed to evaluate the water resources of the Humboldt River Basin. A summarization of much of the technical information on geology and hydrology of the Winnemucca reach is presented in Water Resources Bulletin Number 24, prepared cooperatively by the State of Nevada Department of Conservation and Natural Resources and the U.S. Geological Survey.

Technical reports covering limited or specialized fields have been made at various times in the sub-basin. Their titles are listed in the References section of this report.

GENERAL SUB-BASIN CHARACTERISTICS

Sonoma Sub-Basin is in the west-central part of the Humboldt Basin. Most of the area extends south from the Humboldt River in the vicinity of Winnemucca, but it includes the short drainages north of the river as well as the Humboldt bottomland between Comus and Rose Creek gaging stations. Pumpernickel Valley, which drains into the Humboldt above Comus, is also included. The sub-basin lies in two counties, Humboldt and Pershing, and contains approximately 754,000 acres.

The East Range forms the west boundary, with crest elevations of about 6,500 feet. The Sonoma Range divides Grass Valley and Pumpernickel Valley, and has crests around 7,000 feet. The north end of the Tobin Range, and a short un-named spur connected to the Tobins by Smelser Pass, form the east boundary; these mountains have crest elevations of over 7,000 feet. All these ranges have peaks over 8,000 feet in elevation.

Geology

Consolidated or largely consolidated sedimentary rocks of Paleozoic, Mesozoic, and Tertiary ages are exposed in highland areas. They have been faulted and folded, and include quartzite, chert, argillite, sandstone, shale, slate, phyllitic shale, grit, limestone, and dolomite. These have been intruded by masses of granite and granodiorite which are exposed at scattered locations. The mountain ranges are largely barriers to the lateral movement of ground water, and form ground water divides. Younger volcanic rocks consisting of rhyolite, dacite, basalt, and andesite overlie older sedimentary rocks.

Some valley fill material of Tertiary age has been elevated into mountain blocks by faulting.

Mountain ranges are flanked by coalescent alluvial fans. These fans have slopes up to six degrees near the mountains, and less than one degree where they merge with the valley floor. Some fans terminate at scarps which border the margin of the Humboldt River flood plain, and others merge with the Lahontan Lake plain, as in the northern part of Grass Valley and in Paradise Valley. Alluvial fans which overlap or interfinger with floodplain deposits of the Humboldt River occur largely in the eastern one-quarter of the sub-basin.

Lake Lahontan inundated the area to an elevation of about 4,400 feet. The floors of Paradise and Grass Valleys represent the last deep-water stage of the lake. The beaches have been obscured by erosion and sedimentation and are not readily apparent. Several wave-cut terraces and scarps are prominent, however, and readily discernible at elevations above 4,260 feet. The lake plain has been trenched by the Humboldt River in Humboldt River Valley, and by the Little Humboldt in Paradise Valley. The Humboldt River is presently 20 to 55 feet below the plain.

The Humboldt River flows westerly across the general structural trend of mountains and valleys in the sub-basin. The width of its flood plain ranges between 0.2 and 2.0 miles. The narrow stretches occur at constrictions in Emigrant Canyon near Golconda, at the Winnemucca Narrows, and at Rose Creek. Five plane surfaces are discernable at successively higher elevations between the channel of the Humboldt River and bordering mountains. The lowest surface is the floodplain of the Humboldt. The next two are river-cut terraces referred to as the lower terrace and middle terrace. The fourth surface, referred to as the upper terrace, is the former floor of Lake Lahontan. The highest surface is that of alluvial fans which encroached upon the upper terrace in Grass and Paradise Valleys, and upon lower-lying terraces and the floodplain itself at different locations in the Humboldt River Valley.

The flood plain includes such local physiographic features as sand dunes, which are rarely covered by water. Other characteristic features are meander loops of the river, and meander scrolls of abandoned channels.

Generally, cross-bedded sandy to gravelly point bar deposits occur along the channel meanders. Point bar deposits of abandoned channels are covered with a thin deposit of silty sand to sandy silt. Very fine-grained organic oxbow lake deposits, and possibly fine-grained overbank deposits, may also occur in meander belts, where they overlie sandy and gravelly deposits.

Eolian sand deposits cover much of the Humboldt Valley in the western three-fourths of the sub-basin. Sand dunes occur at the mouth of Paradise Valley and in the northern part of Grass Valley. Those in Grass Valley are stabilized, while those in Paradise Valley have effectively dammed the Little Humboldt River.

Ground Water

Thickness of unconsolidated valley fill is variable in different localities; the maximum thickness is unknown. Upstream from Winnemucca, it attains a thickness of several hundred feet, while downstream it forms a thin veneer over Lake Lahontan sediments. Bedrock is known to occur at relatively shallow depths at a few places beneath the valley floor of the Humboldt; namely, Emigrant Canyon, the Winnemucca narrows, and the Rose Creek constriction. A marked reduction in permeability occurs between generally

unconsolidated Quaternary valley fill and older partially consolidated Tertiary valley fill. Tertiary deposits include sandstone, shale, and mudstone.

Although capable of storing large quantities of ground water when saturated, Tertiary valley fill deposits generally transmit water slowly. Consequently, they usually are not good aquifers, except for stockwatering or other purposes requiring low yields. However, exceptions to this are known in the Humboldt River Basin; a well drilled for the City of Winnemucca encountered fissured lava from 499 to 525 feet below the surface, underlying unconsolidated to partly consolidated valley fill. The lava reportedly yielded part or all of a 1,000 gallon per minute flow.

The valley of the Humboldt River is entrenched in lake- and wind-laid deposits filling an older valley cut in Quaternary valley fill, and possibly other older materials. Exposed deposits indicate two dominantly lacustrine layers separated by a layer of alluvium. The upper layer of lake sediments consists generally of fine-grained silty sand to clay. Deposits in the lower layer include fine-grained silty clay and silt. These fine-grained deposits are generally poor to very poor aquifers. The alluvium includes sandy to gravelly accumulations of variable thickness in different localities, and is generally a good aquifer. Good aquifers also occur in gravelly deposits associated with major streams.

Alluvial fans may be important avenues for ground water recharge. They often contain fair aquifers; the better locations for water-well development usually occur from about half way down to near the toes of fans.

Soils

Soils of the sub-basin have developed on gentle to strongly sloping flood plains and terraces, and moderate to steep mountainous uplands. They have developed in alluvium, colluvium, and residuum from shale, quartzite, chert, and volcanic rocks, under low precipitation.

The soils in the floodplains are generally deep lake-and stream-laid sediments. They are mostly moderately fine to medium textured, poor to moderately well drained, and have salt and alkali concentrations ranging from none to strong.

Light-textured or somewhat sandy soils extend two to three miles on either side of the Humboldt River, but are more extensive on the north side, from Rose Creek to Golconda. These soils are readily susceptible to wind erosion, and as a result have formed a very rough, uneven dune-shaped terrain.

On the upland benches and terraces the soils are generally shallow to deep, medium textured, well drained, and have salt and alkali concentrations varying from none to slight. The shallow soils are underlain by either a cemented claypan or cemented gravel.

The mountain uplands have soils that vary from shallow to deep, medium to gravelly and stony medium textured, and are well to excessively drained.

Precipitation

The climate in the sub-basin is primarily arid, with most of the moisture falling as snow during the winter months. Average annual precipitation in the lowlands varies from six to eight inches. In the uplands and mountainous areas the average precipitation, as determined from storage gages and the water balance studies, was estimated to be as

follows:

East Range precipitation varies by elevation from eight to 15 inches (elevations 5,000 to over 7,000 feet).

Sonoma Range precipitation varies by elevation from eight to 25 inches (elevation 5,000 to over 9,000 feet).

Tobin Range precipitation varies by elevation from eight to 20 inches (elevation 5,000 to over 8,000 feet).

Osgood Mountains precipitation varies by elevation from eight to 15 inches (elevation 5,000 to 8,000 feet).

Hot Springs Range precipitation varies by elevation from eight to 10 inches (elevation 5,000 to over 6,000 feet).

Winnemucca Mountain precipitation varies by elevation from eight to 10 inches (elevations 5,000 to over 6,000 feet).

Average annual precipitation for recording stations in and adjacent to the subbasin, and data from one Cooperative Snow Survey Station, is shown in the following tabulation.

Station	Elevation	Years of record	Average annual precipitation (inches)
Winnemucca	4,300	93	8.5
Golconda	4,400	82	6.0
Paradise Hill	4,500	4	8.9
Storage Gages			
Getchell Mine	6,000	5	13.3
Dutch Flat Mine	5,500	5	8.2
Pole Creek Meadow	6,040	9	20.8
Sonoma Mountain	8,400	6	20.9
Clear Creek Canyon	5,200	5	10.2
Sheep Ranch	5,300	5	10.2
Spaulding Canyon	6,200	4	11.4
Dun Glen Peak	6,000	5	9.7
Snow Survey Station			
Golconda No. 2 (Pole Creek)	6,000	7	3.4 1/

1/ Average April reading (inches of water).

Growing Season

Average annual temperature in the lowlands, between Comus and Rose Creek gaging stations, is estimated to be 49 degrees. The growing season (28 degrees F) averages

Photograph 3. - Desert peachbush, an increaser species in the sage-brush overstory, steep mountain slopes range site , upper Clear Creek, Sonoma Range.
FIELD PARTY PHOTO 6-855-5

Photograph 4. - Great Basin wildrye site on the Pumpernickel Valley-Grass Valley divide, near Panther Canyon. FIELD PARTY PHOTO 6-837-10

Photograph 5. - Big sagebrush and mixed perennial grasses on the light-textured sandhill soils along the Humboldt River southwest of Winnemucca, looking north toward Blue Mountain (extreme background). The range here is in the fairly high range forage production class. FIELD PARTY PHOTO 6-852-10

about 140 days. These data are based on records at Winnemucca (42 years) and Golconda (38 years). There are no records to indicate the length of growing season at the heads of Pumpernickel and Grass Valleys. It is estimated that the average frost-free period would be a few days less than along the Humboldt.

General Cover Types

The predominant vegetal cover over most of the sub-basin is either big sagebrush (Artemisia tridentata)-grass or shadscale (Atriplex confertifolia)-grass, with big sagebrush being more prevalent. Generally, big sagebrush occupies the steep mountain slopes and basins and the upland benches and terraces, but it also can be found fringing the Humboldt River bottomlands wherever the light-textured, well drained dune soils are present. Shadscale occupies the flat uplands and alluvial fans between the valley bottomlands and the rolling foothills in both Grass and Pumpernickel Valleys.

Associated with the big sagebrush in the steep mountain slopes and basins are such other shrubs as serviceberry (Amelanchier spp.), tall rabbitbrush (Chrysothamnus speciosus), snowberry (Symphoricarpos spp.), rock-spirea (Holodiscus spp.), and desert peach (Prunus andersonii). Desert peach is also very common in some areas in the Sonoma range; it appears to be increasing, depending upon the pressure of grazing use (see photograph 3). Grass understory in the big sagebrush sites at the higher elevations consists of cheatgrass (Bromus tectorum), Sandberg bluegrass (Poa secunda), Great Basin wildrye (Elymus cinereus), needle-and-thread grass (Stipa comata) and bluebunch wheatgrass (Agropyron spicatum) (see photograph 4). Cheatgrass is by far the most common grass found throughout the sub-basin on nearly all the range sites. On the west side of Pumpernickel Valley, and on Winnemucca Mountain, cheatgrass has invaded following fire, and now composes at least 80 percent of the total vegetation in these areas.

Black greasewood (Sarcobatus vermiculatus) is generally the dominant plant cover throughout the bottomlands of Grass Valley and the northern half of Pumpernickel Valley. Within or adjacent to the greasewood stands are found a few islands or stringers where quailbrush (Atriplex lentiformis) or rubber rabbitbrush (Chrysothamnus nauseosus) is dominant. Other plants associated as admixtures to the greasewood, rabbitbrush or quailbrush stands are shadscale, bud sagebrush (Artemisia spinescens), fourwing saltbush (Atriplex canescens), Nuttal's saltbush (Atriplex nuttallii), cottonthorn horsebrush (Tetradymia spinosa), seepweed (Suaeda spp.), saltgrass (Distichlis stricta), Great Basin wildrye, bottlebrush squirreltail (Sitanion hystrix), and annual mustards. Scattered plants of alkali rabbitbrush (Chrysothamnus albidus) are found in the semi-playa range site in northern Pumpernickel Valley.

On the light-textured sandy soils bordering the Humboldt River which are subject to dune formation, a wide variety of vegetal species is found, but usually big sagebrush or greasewood predominates. Associated with these two species in the shrub overstory are fourwing saltbush, tall rabbitbrush, spiny hopsage (Grayia spinosa), hairy horsebrush (Tetradymia comosa), littleleaf horsebrush (T. glabrata), and granite gilia (Gilia pungens). Grasses present in the understory, but usually rather widely dispersed, are needle-and-thread grass, Indian ricegrass (Oryzopsis hymenoides), cheatgrass, and bottlebrush squirreltail. (See photograph 5.)

Arrowleaf balsamroot (Balsamorhiza sagittata), buckwheat (Eriogonum spp.), groundsel (Senecio spp.), phlox (Phlox spp.) and lupine (Lupinus spp.) are the principal forbs present with big sagebrush at the higher elevations, while annual mustards, Russian thistle (Salsola (pestifer) kali), evening primrose (Oenthera spp.), and milkvetch (Astragalus spp.) are more common on the sagebrush fans and benches along the river.

Photograph 6. - Shadscale-grass range site in low forage production class, upper Grass Valley. FIELD PARTY PHOTO 6-837-9

Photograph 7. - Low sagebrush-grass range site, upper Pole Creek, looking west toward Sonoma Peak. FIELD PARTY PHOTO 6-785-6

On the shadscale range sites such species as bud sagebrush, bottlebrush squirreltail, Sandberg bluegrass, and cheatgrass are found. The grasses in this range site are widely scattered. (See photograph 6.)

One small remnant of a relatively pure stand of winterfat (Eurotia lanata) is found on the east side of Grass Valley, surrounded by shadscale. Winterfat is present in most of the other range sites throughout the sub-basin, but is widely dispersed.

A relatively small area of black sagebrush (Artemisia nova) is found on the ridgetops and rolling uplands of Golconda Summit, while at the higher elevations of the Sonoma Range, low sagebrush (Artemisia arbuscula) is more prevalent, especially on the northeastern side. Associated with the black sagebrush are such other species as Sandberg bluegrass, bottlebrush squirreltail, and bud sagebrush. Associated with the low sagebrush are such species as Idaho fescue (Festuca idahoensis), bluebunch wheatgrass, Sandberg bluegrass, Nevada bluegrass (Poa nevadensis), serviceberry, snowberry, currants (Ribes spp.), Great Basin wildrye, and western wheatgrass (Agropyron smithii). (See photograph 7.)

An extensive acreage of rubber rabbitbrush is found along the Humboldt River bottomlands, between the Rose Creek gaging station and the mouth of Rose Creek. Species associated with the rabbitbrush are alkali sacaton (Sporobolus airoides), saltgrass, alkali bluegrass (Poa juncifolia), willow (Salix spp.), and black greasewood. (See photograph 8.)

Below Golconda, fringing the cropland along the Humboldt River, are fenced grassland acreages used principally for pasture. This same type is also found for a short distance above the confluence of the Rose Creek drainage and the Humboldt River. Chief species present are Great Basin wildrye, creeping wildrye (Elymus triticoides), saltgrass, alkali sacaton, Nevada bluegrass, and scattered black greasewood and rubber rabbitbrush. Approximately one-half of the total acreage of this grassland type in the sub-basin is found in the bottomlands of Grass Valley. However, here saltgrass and alkali sacaton are the dominant grasses. (See photograph 9.)

Utah juniper (Juniperus osteosperma) is thinly scattered across the western face of the Sonoma Range, and on the ridgetops and fans of the East Range from Dun Glen Peak southward to Table Mountain. Most of the trees are stunted and poorly formed, and have little if any commercial value, for fence posts or otherwise. Other trees in the sub-basin are cottonwood (Populus fremontii) and chokecherry (Prunus virginiania demissa), usually found as thin stringers along most of the creek bottoms; a few small stands of quaking aspen (Populus tremuloides) occur on the north slopes of the Sonomas, near the ridgetops. Several clumps and islands of silver buffaloberry (Shepherdia argentea) are found in the bottomlands of the Humboldt River and Grass Valley.

Water Yield

Streamflow occurs from snowmelt, which is usually early in the irrigation season. None of the drainages originating within the sub-basin yields surface flow to the Humboldt, except during abnormal conditions. Most of the water yield originating within the sub-basin comes from the Sonoma Range, with Pole, Little Rock, Clear and Sonoma Creeks carrying most of the runoff. These streams are perennial in the higher elevations or below springs.

An evaluation of the ground water resources of the Winnemucca Reach was made by the U. S. Geological Survey as part of the interagency Humboldt River Research Project.

Photograph 8. - Rubber rabbitbrush overstory, saline bottomlands range site along the Humboldt River, near the Rose Creek gaging station. (Looking southeast, with Dun Glen Peak and the East Range in the background.) FIELD PARTY PHOTO 6-835-8

Photograph 9. - Fenced grassland fringe to cropland along the Humboldt River, immediately east of Winnemucca. Rubber rabbitbrush and black greasewood form a scattered overstory to the perennial grasses here. (Looking northward toward Winnemucca Mountain.) FIELD PARTY PHOTO 6-862-12

They report an estimated 500,000 acre-feet of ground water in storage under the Humboldt River flood plain and about 1,500,000 acre-feet in storage under Grass Valley. They also estimate the annual subsurface inflow to this reach of the Humboldt to be in the range of 11,000 to 14,000 acre-feet; 5,000 to 6,000 acre-feet from Grass Valley, 3,000 to 3,500 acre-feet from Little Humboldt Sub-Basin, 3,000 to 4,000 acre-feet from Pole-Little Rock Creek area, and 350 to 700 acre-feet in the Humboldt under the Comus gage.

The 80 percent frequency (chance) concept, as computed for previous sub-basins, has only limited value in defining the total available water supply within sub-drainages where recharge potential and ground water storage is large in comparison to expected inflow. Under these conditions, virtually all gross yield in excess of evapotranspiration by crops and phreatophytes finds its way into the ground water basin, and the usuable water supply for such an area approaches the average annual yield less any discharge from the ground water basin. Grass and Pumpernickel Valleys are two examples. Pumpernickel Valley is normally considered to be a closed basin with no excess of supply over use, while U.S. Geological Survey studies show Grass Valley to have a constant annual subsurface outflow. The ground water storage in both these basins is in balance over a cycle of wet and dry years.

Pumping in the Pole-Little Rock Creek Watershed has had little effect on ground water storage. In figure 1, the 2,300 acre-feet of water, which are shown as outflow from the watershed in excess of use, are used in part to irrigate land along the Humboldt in the Comus-Rose Creek Watershed (see figure 2, Appendix 1).

In Grass Valley, pumping has not measurably lowered the overall water table of the valley, reduced ground water use by phreatophytes, or reduced the outflow to Humboldt River. This quantity of water, shown in figure 1 as 3,300 acre-feet, is used by irrigated crops, and is presumed to be drawn from ground water in storage. The withdrawal is not recharged from the average annual yield, and therefore is not included in the water balance calculations.

The calculated 80 percent frequency flow of 63,100 acre-feet at the Rose Creek gage includes 11,000 acre-feet of subsurface inflow into the Humboldt. A flow of this frequency would result from the dry side of a cycle of wet and dry years, and therefore the low figure of the estimated 11,000 to 14,000 constant annual inflow was used.

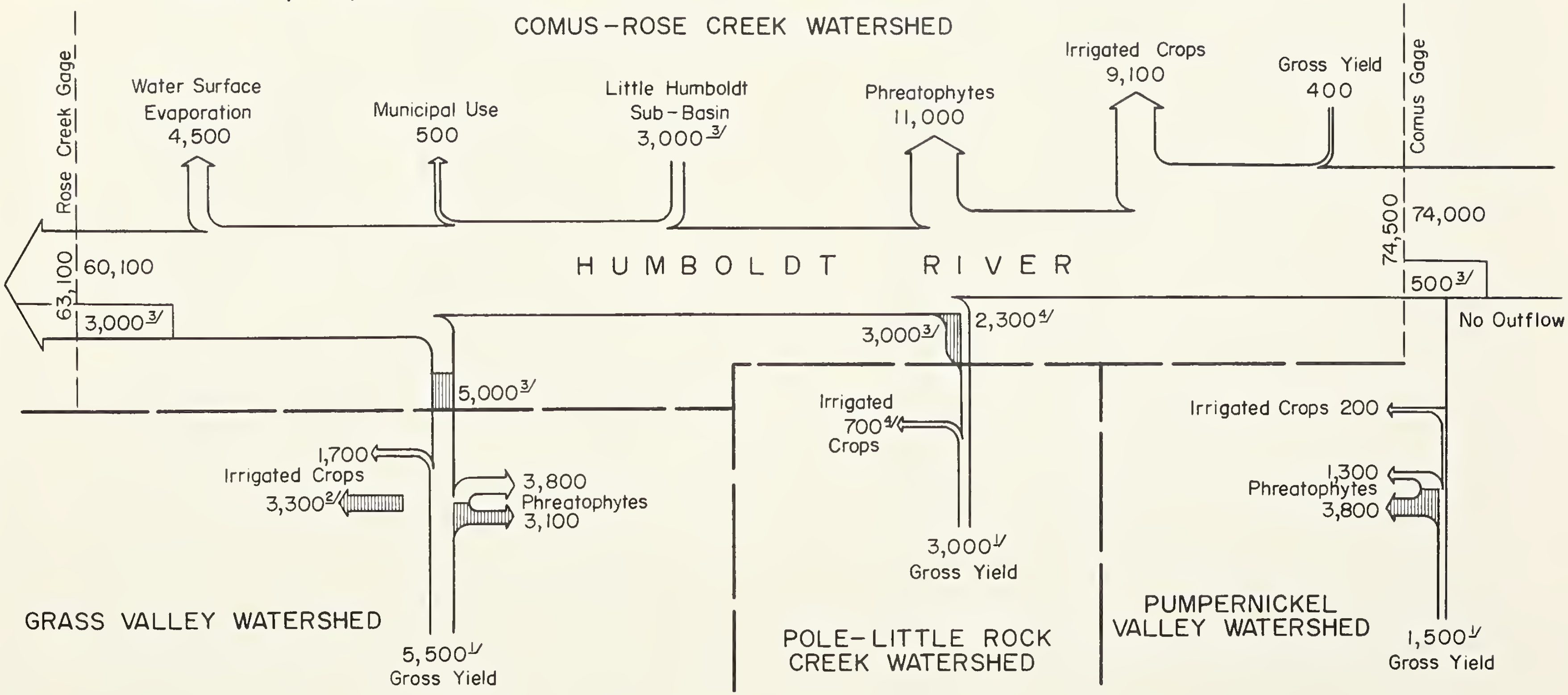
The following tabulation, in acre-feet, is a comparison of the calculated 80 and 50 percent frequency annual surface flows with the average annual flows at the Comus and Rose Creek gages, as computed from streamflow data. (See Water Balance Studies, Appendix 1).

	Comus Gage 49 years record (acre-feet)	Rose Creek Gage 15 years record 1/ (acre-feet)
Average	198,400	150,200
50 percent frequency	150,000	122,000 2/
80 percent frequency	74,000	58,000 2/

1/ Inflow from Gumboot Lake was subtracted from the yearly totals for 1953 and 1958.

2/ The 15-year record was extended to 49 years, on the basis of the Comus gage data.

Figure 1. -- Flow diagram of gross water yields and depletions in acre-feet for watersheds in the Sonoma Sub-Basin for an 80% frequency (chance)



1/ *Average annual yield for Grass Valley is estimated to be about 13,600 acre-feet; Pole-Little Rock Creek, 6,000; and Pumpernickel Valley, 5,300.*

2/ *Withdrawal from ground water storage by pumping which is not recharged by average annual yields and therefore is not included in the water balance calculations.*

3/ *U.S.G.S. estimates of subsurface flow totaling 11,000 to 14,000 acre-feet of inflow and 3,000 acre-feet of outflow.*

4/ *Surface flow is used to satisfy water rights within the Pole-Little Rock Creek Watershed, and at the mouth of Pole Creek in the Comus-Rose Creek Watershed.*

[shaded box] THE ESTIMATED QUANTITY OF WATER USED, OR AS OUTFLOW FROM GROUND STORAGE IN EXCESS OF WATER YIELD.

SOURCE:
HUMBOLDT RIVER BASIN FIELD PARTY,
AND
STATE OF NEVADA WATER RESOURCES BULLETIN 24.

The U.S. Geological Survey estimates of underflow at these gages (350 to 700 acre-feet, Comus; 3,000 acre-feet, Rose Creek) would be in addition to the values given in the tabulation. The surface outflow of 60,100 acre-feet at the Rose Creek gage, as computed by the Field Party (see figure 1), can be compared to the 58,000 acre-feet calculated from the stream gage readings and shown in the preceding tabulation. The two values are in close agreement; the difference, 2,100 acre-feet, is less than four percent variation between the two procedures.

Records show the extremes in surface flow at the Comus gage vary between no flow at times to 5,860 c.f.s. (May 6, 1952). At Rose Creek the extremes vary between a low of 3.7 c.f.s. (December 27, 1959) to a high of 5,810 c.f.s. (May 8, 1952).

Pole Creek is the only tributary stream in the sub-basin which is gaged. Streamflow data at the Pole Creek gage indicate an average annual gross yield of 3,000 acre-feet, which is used, along with surface flow from Little Rock Creek, on irrigated cropland above the flood plain of the Humboldt. The maximum estimated flow on Pole Creek was 4,000 c.f.s. from a convection storm on August 5, 1961; this same storm on Clear Creek produced an estimated flow of 11,500 c.f.s.

There are an estimated 80 water wells in the sub-basin, with capacities ranging from a few gallons per minute to 3,000 g.p.m. Of this number, 60 are currently being pumped for irrigation. The remainder are used for culinary, livestock, and municipal purposes.

A flow diagram of gross water yields and depletions - 80 percent frequency (chance) - for watersheds in the sub-basin is illustrated in figure 1 (see also Annual Water Balance Study, Appendix 1).

LAND AND WATER USE

Land Status

There are an estimated 100 land owners in the sub-basin, not including lands within the boundaries of municipalities, small communities, or other small tract subdivisions. These ownership data were obtained from the Winnemucca offices of the Bureau of Land Management and Soil Conservation Service. Sections of Federal and private lands are intermingled in a checkerboard pattern on about three-fourths of the area. Included in the private land are an estimated 42,200 acres owned by the Southern Pacific Land Company.

The approximate land status breakdown is as follows:

Land Status	Square miles	Acres	Percent of total
Public Domain	716.9	458,800	60.8
Private	455.6	291,600	38.7
Indian Colony (Winnemucca)	.5	300	----
County and State	2.0	1,300	0.2
U. S. Bureau of Reclamation	3.1	2,000	0.3
Total	1,178.1	754,000	100.0

Land Use

The public domain (national land reserve) is used primarily for grazing of domestic livestock. Grazing licenses are issued on the basis of spring-fall, winter, and summer range use, depending upon location and type of range. Portions of these lands also serve as habitat for big game and other wildlife. The long-range land program of the Bureau of Land Management includes encouragement of land exchanges, in order to establish a more desirable land ownership pattern, particularly on high watershed lands. The bulk of the current grazing on public domain range is in community allotments, although a small number of individual allotments has been established and the division of range into individual allotments is progressing. Recreation is becoming an important phase of the Bureau of Land Management program. The Bureau's proposed recreation development program is briefly discussed in the recreation and wildlife section.

Private lands are used for the production of irrigated crops and range forage. In many instances exchange of use agreements are developed with the owners of private intermingled lands, and these areas are then administered with public lands by the Bureau of Land Management. Most of the irrigated land is used to produce winter feed for livestock.

The private land in this sub-basin which was purchased by the Bureau of Reclamation as part of the Humboldt Project (Rye Patch Reservoir) is located at the mouth of Pumpernickel Valley. At present, this land is leased by the Bureau to ranchers for grazing.

Water Rights

Water rights were established by the George A. Bartlett Decree of 1931 and subsequent permits from the State Engineer's office. In general, the decreed rights provide for a flow of 0.81 c.f.s. per 100 acres of decreed land, or at proportional rates, for specific periods of time. The following tabulation shows the present approximate acre-feet of decreed water, date of use, and acres of decreed land along the Humboldt River within the sub-basin. Permitted rights along the Humboldt and in Grass and Pumpernickel Valleys are not included.

Class of land		Dates of use	Decreed water (acre-feet)	Decreed land (acres)
Harvest	(A)	3/15-9/15	26,810	8,940
Meadow pasture	(B)	3/15-6/13	2,990	2,000
Diversified pasture	(C)	3/15-4/28	4,440	5,920
Total			34,240	16,860

Water Use

The annual water balance studies made by the Field Party indicate that during an 80 percent frequency (chance) flow year the estimated water requirements for phreatophytic plant growth, plus irrigation and municipal uses and surface water evaporation, are as follows:

	Acres	Water use acre-feet
Irrigated crops	13,000	15,000
Phreatophytes	57,000	23,000
Direct evaporation from water surface	------	4,500
Municipal water	------	500
Total		43,000

In Pumpernickel and Grass Valleys the annual water requirements are greater than the estimated gross water yield as frequently as seven to eight years out of 10 (see Annual Water Balance Study, Appendix I). It is assumed that the additional water required is available from ground water storage, and that such storage remains in balance over a cycle of wet and dry years. In Grass Valley, an estimated 3,300 acre-feet of unreplenished water are currently being pumped from ground water storage for irrigation. Additional studies would be required to determine what effect this pumping, or additional pumping, might have on phreatophytic use or subsurface outflow from the valley.

The following tabulation shows the crops that are grown in the sub-basin, based on the 1963 crop year, with the estimated acreage.

Watershed	Alfalfa	Grain	Meadow native hay
Comus-Rose Creek	950	---	7,200
Grass Valley	1,700	600	1,700
Pole-Little Rock Creek	150	---	500
Pumpernickel Valley	100	---	100
Total	2,900	600	9,500

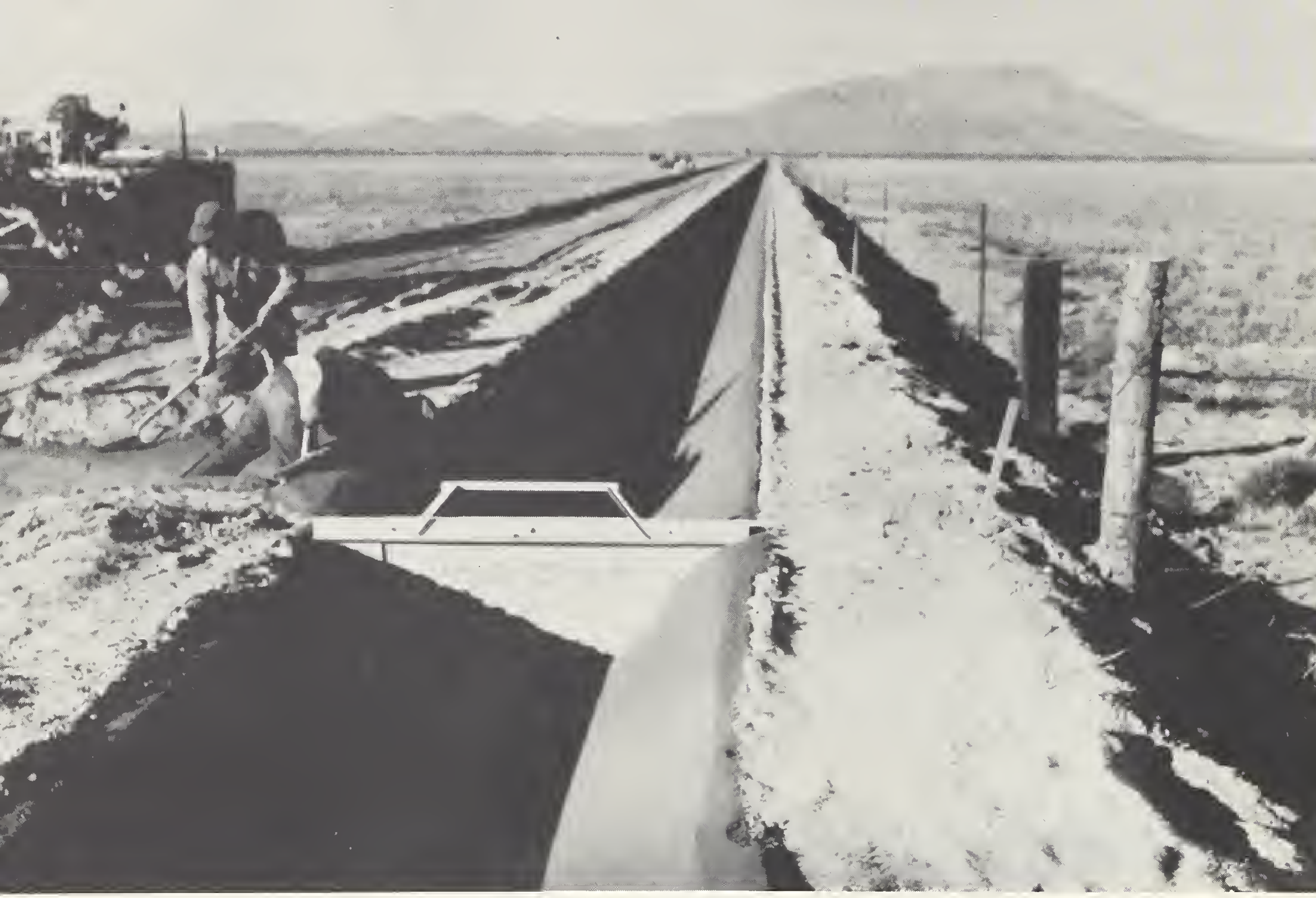
In addition, there are about 5,000 acres of subirrigated native pasture species which, for the purpose of these studies, were classified as phreatophytes; this land is located mostly along the Humboldt, and is flooded only during periods of high water. Surface flow from Pole and Little Rock Creeks, when it is available, is also used to supplement pumping and diversions from the Humboldt on the Diamond S Ranch, west of Golconda.

Water from wells, springs, and reservoirs is used mostly to irrigate 3,500 acres planted to alfalfa or grain. Native hay and pasture lands are primarily irrigated from surface flow.

Irrigation Methods

Improved irrigation developments consist of an estimated 2,200 acres of land leveling, 650 acres of land smoothing, 5,780 feet of pipe line, 1,930 feet of concrete ditch lining, 10 overnight storage reservoirs, five spring developments, and 60 water wells (see photograph 10). In addition, a few improved diversion and other water control structures have been installed.

An estimated 2,300 acres are irrigated by the border method, and 890 acres are irrigated by sprinklers. The remaining cropland is irrigated, when water is available, by flooding from direct diversion of channel flow. Five of the overnight storage reservoirs were developed in conjunction with pumping of well water, to afford better control of the quantity of water used when irrigating (see photograph 11). The remaining reservoirs were constructed as integral parts of spring developments, to increase the size of the irrigating heads.



Photograph 10. - Installation of concrete lining in an irrigation ditch lateral, lower Grass Valley. SCS PHOTO 6-649-11

Photograph 11. - Overnight storage reservoir used in conjunction with well-pumping for cropland irrigation, lower Grass Valley. FIELD PARTY PHOTO 6-837-2

THE AGRICULTURAL INDUSTRY

The Sonoma Sub-Basin is located in both Humboldt and Pershing Counties. However, the cropland is largely in Humboldt County, and the agriculture of the sub-basin is more like that of Humboldt than of Pershing County. Livestock raising is the principal enterprise in Humboldt County; in Pershing County, ranchers operate on a more diversified basis.

Data presented here were developed from ranch conservation plans, University of Nevada bulletins, the U.S. Census of Agriculture, and individual ranch observations. Data from the Census of Agriculture reflecting various agricultural trends for the two counties were also considered.

Ranch Characteristics

At the present there are 53 ranches in the sub-basin, practically all of which are headquartered there. Some ranches are completely within the sub-basin, while others have holdings outside its boundaries.

Thirty-six of the 53 ranches are commercial operations deriving the major portion of their income from the production and sale of livestock and livestock products. The remaining 17 are hobby-type operations, with the majority having a small number of horses and cattle; units range in size from five to 100 acres, grazing not over 50 head of cattle for the combined group.

One cattle rancher has diversified his holdings by including a hog enterprise, with about 20 brood sows. Another rancher is in the process of establishing a grade-A dairy.

Size of ranch varies widely in the sub-basin. About 40 percent of the ranchers have less than 100 acres of private land, while 10 percent have 10,000 acres or more. Ranch holdings range in size from five to 50,000 acres of privately-owned land. Average size of ranch is presently on the increase. In addition to owning or leasing private range, pasture, and cropland, most of the larger ranchers also hold licenses to graze livestock on Federal rangeland.

Size distribution of private ranchland acreages in the sub-basin is as follows:

Acres	Number of ranches
Less than 100	22
100 to 499	9
500 to 999	7
1,000 to 9,999	9
10,000 and over	6
Total	53

The cropland in the sub-basin is devoted primarily to the production of winter feed for cattle, horses, and sheep. Distribution of irrigated cropland acreages in the sub-basin is as follows:

Cropland acres	Number of ranches
None	7
1 to 24	17
25 to 99	8
100 to 499	12
500 and over	9
Total	53

About 65 percent of the ranches are owner-operated; the remainder is divided as follows: part-owners, 20 percent; managers, 10 percent; and tenants, five percent.

About 90 percent or more of the sub-basin's gross receipts is derived from the sales of livestock and livestock products. Only a small income is derived from the production and sale of dairy products, poultry and poultry products, and hogs. From 1954 to 1959, gross receipts in Humboldt and Pershing Counties increased 35 and 54 percent, respectively. Over the same period, cash farm expenditures rose 45 percent in Humboldt County, and 49 percent in Pershing County.

Ranch expenditures, both capital and operating, have increased during the last 10 years. Expenses for gasoline and other petroleum products and livestock and poultry feed have been the major sources of increased operating costs. Higher ranch expenditures for feed have been brought about by increased prices, which in turn reflect greater cost of production. Greater gasoline and other petroleum costs were principally the result of ranch mechanization.

The value of farm products sold and farm expenditures for Humboldt and Pershing Counties for 1954 and 1959 are as follows:

Item	Humboldt County		Pershing County	
	1954	1959	1954	1959
	Dollars			
Products sold				
Any livestock sold alive	2,183,007	6,248,587	1,406,280	3,850,826
Poultry and poultry products	10,138	6,537	6,917	3,010
Livestock products other than poultry	71,807	57,694	37,794	36,232
Value of livestock and products including dairy	2,264,952	6,312,818	1,450,991	3,890,068
Field crops	89,337	374,928	1,252,867	1,137,613
Vegetables	300	200	30	---------
Fruit	23	3,814	5	5
All crops	89,660	378,942	1,252,902	1,137,618
All farm products	2,354,612	6,691,760	2,703,893	5,027,686
Farm expenditures				
Feed for livestock and poultry	366,290	1,240,896	99,001	775,564
Purchase of livestock and poultry	1/	2,130,127	1/	550,285
Machine hire	14,705	75,758	147,692	174,904
Hired labor	532,222	731,733	372,078	470,346
Gasoline and other petroleum	159,741	326,154	156,910	171,387
Seed, plant and trees	1/	40,192	1/	19,565

1/ Not available.

Source: U.S. Census of Agriculture.

Photograph 12. - Combine-harvesting of wheat, lower Grass Valley. SCS PHOTO 6-409-12

Crop Production

About 13,000 acres of cropland are harvested for hay during an 80 percent frequency (chance) year. During greater water deficiency years the acreage of cropland harvested may be sharply reduced. All excess hay left after winter feeding is held over to prevent serious shortages in drought years. Areas of Great Basin wildrye, alkali sacaton, and saltgrass fringing the hay lands furnish some spring-fall pasture for cattle and horses.

Nine thousand five hundred acres are in native meadow hay, and are flood-irrigated. This hay yields from 0.5 to 1.25 tons per acre, with an average of about .75 tons; an additional A.U.M. of aftermath grazing is generally utilized in the fall after cattle come off the range.

In 1963, 2,900 acres of alfalfa and alfalfa-grass were harvested for hay in the sub-basin. Alfalfa yields vary from 3.0 to 6.5 tons per acre from two or three cuttings, depending principally upon available water, soils, operator's desires and needs, and length of growing season; average yield is about four tons per acre. Most of the alfalfa acreage is under pump irrigation; however, a small acreage is irrigated only periodically from springs or surface flow.

Six hundred acres were planted to grain in the sub-basin in 1963. Not all the grain planted was combined; some was harvested as hay. Pump irrigation provided a full supply of water for the grain acreage. (See photograph 12.)

Irrigated native pastures yield from one to three A.U.M's of feed per acre annually. There are at least 95 acres of improved irrigated pasture managed under a program of deferred-rotation grazing which yield an estimated maximum of 10 A.U.M.'s per acre. (See photograph 13.)

Hay provides 25 to 30 percent of the feed requirement for livestock in the sub-basin. Grazing on crop aftermath and adjacent dry and irrigated pastures furnishes from 15 to 20 percent of the feed requirement. The remaining 50 to 60 percent is harvested from intermingled Federal and private winter, spring-fall and summer rangeland.

Livestock Production

The sheep industry has been decreasing in importance over the past 30 years, and at present there are only about 4,000 head in the sub-basin. No operations produce sheep as a principal enterprise, and only three major operators have combined cattle and sheep.

Ranchers with sheep graze their flocks throughout the year on intermingled Federal and private rangeland. Some sheepmen gather their bands during lambing time, often provide supplemental feed, and assist the lambing ewes. At present, the lamb crop is about 85 percent. Some lambs have sufficient finish when they come off the range to go directly to packers, while the remainder are fed out in nearby States.

Cattle and calves on ranches in the sub-basin almost doubled in number from 1939 to 1959. This increase was partially the result of shifts from sheep to cattle enterprises. There are now an estimated 20,000 head of cattle on sub-basin ranches. The number of ranches, grouped on the basis of herd size, is as follows:

Number of cattle	Number of ranches
Less then 200	32
200 to 999	15
1,000 and over	6
Total	53

Photograph 13. - Calves on improved irrigated pasture (Alta fescue, smooth brome), lower Grass Valley. FIELD PARTY PHOTO 6-837-3

Most cows are bred to calve in the early spring, although some calves are born throughout the year. The calf crop varies among ranches from 45 to 90 percent, averaging about 70 percent. There does not seem to be a correlation between size of enterprise and percent calf crop. Some ranches are realizing high calf crops through improved management.

Weaning weights of calves in the area range from 250 to 350 pounds, depending upon date of birth, available forage, and hereditary growth potential; they average about 300 pounds.

A study by the University of Nevada shows that California market demands for all in-shipments of cattle have grown over a 20-year period (1939-1959) at 3.75 percent per year, but Nevada shipments to California over the same period have increased only 2.34 percent per year for all classes. During post-war years (1947 to 1959) there was only a slight increase in numbers shipped for combined slaughter and stocker-feeder purposes. The number of cattle shipped to California for immediate slaughter has decreased, mainly through changes in grade demanded by California packers.

California packers and feeders now receive about 50 percent of the cattle shipped. Idaho receives about 20 percent of the exports, 20 percent remain in Nevada but are shipped to other areas, and the remaining 10 percent are shipped to other western States.

An estimated 10,000 head of cattle and calves and 3,000 sheep and lambs are produced and shipped from the Sonoma Sub-Basin annually. Classes of cattle shipped are steers, 30 percent; heifers, 15 percent; cows, 15 percent; mixed calves, 15 percent; and all others, 25 percent.

The majority of livestock is contracted for sale. Cows and bulls are often sold at auction or to local buyers, with buyers generally paying all shipping costs.

Transportation

Trucks transport practically all (96 percent) of the cattle leaving Humboldt and Pershing Counties. The percentage trucked from the Sonoma Sub-Basin would probably be somewhat less, because of the ready availability of through railroad transportation. Several motor freight common carriers maintain terminals in Winnemucca and provide interstate service to all parts of the nation. Some local carriers provide intrastate service. Idaho and California truck carriers also transport livestock from the sub-basin.

Transportation facilities available to sub-basin ranches are adequate. Two interstate railroads, Southern Pacific and Western Pacific, serve the area and provide daily schedules to the west coast and to Ogden, Salt Lake City, and points east. Both railroads offer livestock transportation service, with loading facilities at Winnemucca and Golconda.

Transcontinental U.S. Highway 40 (Interstate 80) links the sub-basin with eastern and western points, and U.S. Highway 95 at Winnemucca provides access to southern Oregon, southwest Idaho, and northern California. During good weather, numerous other roads and truck trails provide access to most parts of the sub-basin.

WATER-RELATED PROBLEMS IN THE SUB-BASIN

Agricultural Water Management

Seasonal Distribution of Water

Snowmelt runoff from the drainages in the sub-basin usually occurs from April through June, with peak flows in May. Time and quantity of flow can vary considerably, however, depending upon soil and climatic conditions. Flow in the Humboldt occurs from March through July, with peak flows in May and June.

Land irrigated from direct diversion of surface flow, for the most part, receives irrigation only during the spring runoff. Generally, the conditions resulting from short seasonal stream flow are more favorable for the growing of low-yielding forage plants which tolerate wide extremes in soil moisture over extensive periods of time.

Soils

The principal soils problems on irrigated land are high water table, poor drainage, salt and alkali concentrations, and light-textured soils subject to wind erosion. These problems usually occur in the Humic Gley, Alluvial and Solonetz Soils which are found on the flatter slopes in the valley bottoms, and the Regosol Soils on the benches and fans immediately above the Humboldt bottomlands.

Seepage Loss

Water loss from surface to ground water was observed to be very high in ditches and stream channels flowing over alluvial fans. During years with low precipitation, this seepage loss limits the acreage which can be irrigated by surface flow from local mountain streams.

Drainage

In some areas, salt and alkali concentrations and high water table limit the type of crops that can be grown and the crop yields. Most of the trouble spots are caused by high water table and over-irrigation.

Irrigation Efficiency

On-the-farm irrigation efficiency (amount of water required to bring the soil in the root zone to field capacity, divided by the amount of water applied) is variable throughout the sub-basin. On fields that have been leveled or smoothed and irrigated with pumped water or from springs, the efficiency is estimated to range from 30 to 50 percent. Fields that are flood-irrigated from surface flow usually obtain less efficient water use; estimated to be 20 percent or less.

Control of Water

About 60 percent of the cropland is irrigated only during the spring runoff period. It is difficult to increase crop yields and improve the type of forage grown without the development of a late-season water supply. Diversions with adequate control features, channel clearing, and additional field ditches would also be needed along the Humboldt bottomland. Pipe lines, ditch lining, turnouts, and drop structures would be needed in other locations, particularly on alluvial fans and fields with light-textured soils.

Flood Damage

There have been many periods of flooding and high water in the sub-basin. Both flood types - wet-mantle and dry-mantle - have been destructive, in terms of recorded flood, erosion, and sediment damage.

The wet-mantle flood results from the complete saturation of the soil mantle, to the point of overland flow. This condition is brought about by extended periods of warm winter rain, rain-on-snow or frozen ground during the winter months, or the rapid melting of abnormal snow accumulations in the spring.

The dry-mantle flood is primarily a summer occurrence, resulting from relatively short periods of heavy rain from summer thunderstorms on dry soils with a thin or depleted vegetal cover, whereby the soil mantle is only superficially wetted by the beating rain. Most of the sudden downpour then runs off in the form of overland flows. The dry-mantle type occurs less frequently along the Humboldt, and is usually confined to the stream sources on the higher watersheds, although it often can (and does) cause severe localized downstream damage.

Wet-Mantle Floods

Floods of December 1861-January 1862 and December 1867-January 1868, as well as floods prior to this period, undoubtedly inflicted damage to this part of the Humboldt Basin. The 1867-1868 floods resulted in an extensive overflow of the Humboldt at French Bridge (Winnemucca), but there are no records of specific damage.

January 16-19, 1875. - Heavy snow, followed by warm winds and heavy rain, caused flooding throughout the sub-basin. Torrents of mud and rock flowed from almost every canyon in the Dun Glen Range. Grass Valley was submerged to a depth of several feet, forming a lake three miles long and one-half mile wide. A ranch house was flooded, forcing the family to flee to Winnemucca.

Washouts occurred in three places along the Central Pacific (Southern Pacific) grade from Winnemucca east 25 miles to Stonehouse. A repair train was derailed, and there was an approximate two-day delay to train movements.

May - June 1884. - The melting of deep snow accumulations, in association with a prolonged period of rain (mid-May to June 20), caused flooding in California, Nevada, and Utah. At Winnemucca the Humboldt, which had started rising on May 20, was described on June 12 as "a vast sheet of water". Both approaches to the Bridge Street bridge were weakened and almost lost.

Cross Creek, which flows through Winnemucca out of Water Canyon from the Sonoma Range, was swollen by the almost incessant rains, and washed away many road bridges in and above town, and also a large railroad culvert.

Between Winnemucca and Lovelock the flooding Humboldt and water emanating from the normally dry canyons of the Humboldt Range caused much damage, in addition to extended delays in train movements.

March 7 - June 5, 1890. - Flooding all along the Humboldt Basin resulted from the melting of massive snow accumulations of the "White Winter" of 1889-1890. Several washouts occurred on the Central Pacific between Winnemucca and Golconda, and the Little Humboldt River broke through the sand dunes to the Humboldt. A lake five to six miles long was formed in Grass Valley, primarily from flooding Sonoma and Record Creeks.

March 6 - April 21, 1907. - Heavy spring rains, falling on a large winter snowpack, caused flooding in the lower Humboldt Basin. Damage was reported to cropland and roads in Grass Valley from Clear Creek and Sonoma Creek. On Clear Creek a prospector's tent and equipment were washed away, but the prospector escaped. One man was drowned in the Humboldt near Iron Point. Some damage was done to the Winnemucca power house and other structures along the Humboldt, including the approaches to the Bridge Street bridge. The Southern Pacific grade between Golconda and Winnemucca was badly washed, which caused considerable delay to train movements. The Little Humboldt broke through to the Humboldt, and added its contribution to the Humboldt floodwaters.

February 18 - March 15, 1910. - Extended periods of warm rain on heavy snow or frozen ground caused flooding in eastern Nevada, particularly in the Humboldt Basin. Through Winnemucca the Humboldt reached the doors of the Winnemucca Hotel on Bridge Street on the south, and lapped the top of the Western Pacific grade on the north side of the river. On March 1, the water was a foot deep over the bridge floor, and both approaches were washed out. In addition, levees washed out, and riverside businesses and residences were flooded. Heavy losses of livestock occurred all along the Humboldt. Later that year, the damaged, weakened Bridge Street iron bridge was replaced by the present concrete structure (see photograph 2). A Western Pacific freight train was derailed into the river on March 15, and the railroad grade and bridge east of Winnemucca heavily damaged. The Little Humboldt broke through the Sand Dunes from Gumboot Lake to the Humboldt, with a large head of water.

January 1 - April 1, 1914. - Two periods of storms caused damage throughout the Humboldt Basin. The first (January 1-26) was caused by heavy snows and rains, and the second, in late February and early March, by rains and rapid melting of a heavy snowpack at the higher elevations.

There was considerable road damage all over Humboldt County. The Humboldt overflowed its banks at Golconda, and caused some flood and sediment damage there. At Winnemucca riverside residences and businesses were flooded, and cropland was damaged by the inundation and sediment.

The Little Humboldt broke through from Gumboot Lake to the Humboldt for the fourth time since the white man's occupancy in the 1860's.

April 3 - May 1, 1942. - Heavy warm rains, accompanied by south winds on April 3 and 4, which melted unusually deep snow accumulations on the lower slopes in the upper Humboldt Basin, caused flooding along the Humboldt River.

There was flood damage along the bottomland east of Winnemucca. The riverside residences and businesses at Winnemucca were saved by levees and sandbagging.

January 21-27, 1943. - A terrific driving rainstorm which lashed all of Nevada on January 20 and 21 melted the winter snow and caused flooding along the Humboldt. Damage to the Winnemucca area was less than that experienced in 1942.

February - May 1952. - This system-wide flooding of the Humboldt resulted from the melting of enormous masses of snow accumulated during the winter of 1951-1952.

At Winnemucca, by April 22 many residences on the south side of the river were being flooded; there were two feet of water in some homes. By May 7 the Humboldt was lapping at the underside of the new U.S. 95 highway bridge, which, it was thought, had

been built to pass any possible flood crest. "Tight dams" not washed out were blown out all along the Humboldt main stem, to relieve any impediment to the river's flow.

Dry-Mantle Floods

July 13-25, 1874. - Perhaps the earliest record of summer dry-mantle flooding along the Humboldt. There was localized severe flooding all through the Humboldt Basin.

On July 13 a cloudburst along the crest of the East Range sent torrents of water 30 to 40 yards wide racing down Spaulding Canyon. Several miles of wagon road in the canyon were washed away.

July 23-25, 1876. - A very hot, humid summer culminated in violent thunderstorm activity and flooding all across northern Nevada.

On July 23 a storm hit between Winnemucca and Mill City, causing track damage along the Central Pacific and flooding along the Humboldt bottomlands; several head of horses and cattle were drowned.

At Golconda, on July 24 a flood from Pole Canyon came through the town, doing little damage; a flock of chickens was drowned and the jittery inhabitants of Golconda were badly frightened.

August 15-16, 1878. - Prior to this period, Nevada had experienced a hot, dry summer, with little or no precipitation. On August 15, floods washed out the Central Pacific line at scattered points between Winnemucca and Lovelock, delaying the train service several hours.

June 5-15, 1882. - A series of almost daily heavy afternoon thunder showers occurred from the Sierra Nevada east to Winnemucca, accompanied by an unusual amount of electrical disturbance.

Intermittent cloudbursts along the Humboldt produced localized and sporadic flooding of the Central Pacific main line between Winnemucca and Lovelock, delaying train movements.

August 4-20, 1884. - This period of wet weather was widespread across northern Nevada. 1884 is one of the few years of record to have both wet-mantle and dry-mantle flood periods.

On August 9, a cloudburst in the Sonoma Range east of Winnemucca sent a large volume of water down Cross Creek, which was at that time the source of Winnemucca's water supply. The water caused severe channel-cutting along the creek and deposited a large amount of sediment, as well as causing extensive railroad bridge and culvert damage in the vicinity of Winnemucca. For several days Winnemucca's domestic water ran muddy in the pipes.

May 1906. - Heavy rainfall at the head of Pole Creek Canyon, south of Golconda, on May 28 caused the Dutertre reservoir dam to break. Six men were drowned when a seven-foot wall of water hit a sheep-shearing camp in the canyon about four miles below the dam. A house, shearing corrals, one horse, two mules, two wagons, 16 sacks of wool, as well as a boiler, engine, and dipping vats at the camp were washed away.

Photograph 14. - Stream channel damage and debris disposition, lower Clear Creek, Sonoma Range. The value of this once fine trout fishery as a fish habitat is now lost. FIELD PARTY PHOTO 6-802-10

At Golconda cellars were flooded and a mile of Southern Pacific tracks was undermined from the Pole Creek water; trains were delayed eight hours.

July 18-25, 1913. - A State-wide series of daily thunderstorms during this period wreaked localized damage along the lower Humboldt.

Heavy rains in the Sonoma Range caused damage at Golconda and in Grass Valley. One auto was buried in mud by a wall of water near Golconda; houses in Golconda were flooded. Washins of mud and rocks buried several hundred feet of Western Pacific and Southern Pacific tracks near Golconda, delaying train movements on both lines from four to six hours. Grass Valley, south of Winnemucca, was extensively flooded, inflicting damage to roads, irrigation ditches, etc., in that area.

June 18-22, 1918. - This series of daily heavy summer thunderstorms, described as the greatest for 30 years in one Winnemucca paper, caused localized damage over the Humboldt Basin. Roads and irrigation ditches were damaged south and west of Winnemucca, and a ranch at the mouth of Rose Creek was damaged. In addition, silt deposition, mud-rock flows over meadows, stream channel cutting, etc. caused widespread damage.

August 5-28, 1961. - A series of almost State-wide daily thunderstorms during this period caused widespread localized damage throughout the Humboldt Basin. On August 5 both Pole Creek and Clear Creek registered their maximum peak flows, estimated at 4,000 and 11,400 c.f.s., respectively, causing severe stream channel erosion and sediment deposition damage. On Clear Creek, the already depleted fishery resource was so severely damaged that this stream presently has little or no fishing significance. (See photograph 14.)

Photograph 15. - Depleted range and watershed lands, upper Clear Creek, Sonoma Range. Indicators of watershed deterioration here are the heavily stagged and hummocked sagebrush, with its extensive cheatgrass understory, rill erosion at the stream sources, and severe stream channel degradation. FIELD PARTY PHOTO 6-855-1

Additional Flood Information, 1861-1962

Detailed information concerning both wet-mantle and dry-mantle floods affecting the sub-basin over the years is presented in the separate report of the Field Party entitled Chronology of Flood Years and High Water Years.

Vegetal Conditions

Range and Watershed

Nearly all the rangelands except a few isolated areas are in a deteriorated condition, and are producing far below their potential. In some cases, as in the Clear Creek watershed, deterioration is so severe that even prolonged protection for many years, and extensive restoration practices, will not bring this watershed back to where it will be suitable for livestock use. Other rangelands with moderate to severe range depletion are located in the Bardmess Pass and Spaulding Canyon areas. (See photograph 15.)

Ninety-two percent of the sub-basin is in the low forage production class, six percent in the medium, and two percent in the fairly high. Table 1 indicates the acreage by classes of present and potential annual forage production, grouped by soils for each vegetal type and site. The rates in this table are indicative of the total annual forage production, and will be used as a basis for planning needs only. Forage production figures of themselves cannot be used for assigning range carrying capacities. Determination of these carrying capacities would also need to consider such factors as slope, soil depth, soil character and stability, and the management objectives of the administrative agency or private owners.

Clear Creek, once a fine, clear trout stream, with its poplar, willow, and choke-cherry-fringed deep holes and sparkling riffles, is now gullied and strewn throughout the length of its bottom with dead tree trunks and limbs, dead or dying willows, decaying sagebrush, and thick, extensive gravel and mud-rock flow deposits (see photographs 14 and 16). The stream is presently intermittent, and has little or no potential value as a trout stream, either now or in the foreseeable future (see photograph 17). Nearly all the side drainages and slopes draining into Clear Creek have active rill, sheet and gully erosion (see photograph 18). This watershed includes approximately 20,000 acres in the Sonoma Range. Other creeks and drainages in this range show evidence of active erosion and range depletion, particularly Pole Creek, but none has been exploited to the same degree as the Clear Creek watershed.

The major areas of rangeland in the medium or fairly high forage production classes are found on the north extension of the Tobin Range in the south end of Pumpernickel

Photograph 16. - Advanced stream channel cutting, south fork of Clear Creek. Note the dead or dying willows, bank-cutting, and sedimentation along the channel.

FIELD PARTY PHOTO 6-802-11

Photograph 17. - The severely eroded channel of lower Clear Creek now occupies the whole canyon bottom. The present small intermittent stream coursing the canyon reach, often quickly swollen to a muddy, debris-strewn torrent, has little or no value as a trout habitat. FIELD PARTY PHOTO 6-855-3

Photograph 18. - Heavy sheet and rill erosion at the stream source, south fork of Clear Creek, Sonoma Range. The ability of this watershed to retain and store precipitation is obviously low to nonexistent. FIELD PARTY PHOTO 6-855-6

Valley, the pass area between Pumpernickel and Grass Valleys in the vicinity of Panther Canyon, and a small isolated shadscale area on the west side of Grass Valley, a few miles north of the Pronto Plata Mine (see photograph 19). In addition, all of the black sage and approximately one-half of the shadscale range sites on Golconda Summit are in the medium forage production class.

Along the Humboldt River are a few small areas of semi-wet meadow and big sagebrush-grass range sites in the medium or fairly high forage production classes. Approximately two-thirds of the crested wheatgrass seedings east of Winnemucca are in the fairly high forage production class, while the remainder is about equally divided between the low and medium production classes.

Phreatophytes

The principal phreatophytes are black greasewood, the rabbitbrushes, quailbrush, willow, cattails (Tyha latifolia), bulrushes (Scirpus validus), seepweed, silver buffaloberry, Great Basin wildrye, creeping wildrye, alkali sacaton, and saltgrass. These species occur in varying densities and combinations. Black greasewood is the dominant phreatophyte, and grows as a scattered, stunted shrub on the semi-playa range site in Pumpernickel Valley. Along the Humboldt River and in Grass Valley, it appears as a large robust bush, three feet or more in height. The phreatophytes occur mainly in three range sites: (1) saline bottomlands; (2) semi-wet meadows; and (3) semi-playas. The phreatophyte communities in these range sites occupy approximately 95,000 acres, or 13 percent of the total sub-basin area. However, because some of the species within this area are not phreatophytes, the acreage occupied by phreatophytes alone is estimated to be somewhat less (approximately 57,000 acres). Total use of water by all phreatophytes is estimated to be 23,000 acre-feet. Of this total, 16,000 acre-feet are consumed by nonbeneficial varieties. Willows and their associated species occupy approximately 1,200 acres in the sub-basin, and are estimated to be using 2,000 acre-feet of water annually (see photograph 20).

The most extensive areas of phreatophytes are in the bottomlands of Grass Valley, the northern half of Pumpernickel Valley, and in the fringe areas on both sides of the Humboldt River bottomlands, with the greater acreage along the Humboldt being found at the confluence of the Little Humboldt River and the main river.

In Grass Valley nearly all the bottomland is covered with some type of phreatophytic growth, with greasewood being the most common species. However, there is a relatively small area where rubber rabbitbrush is dominant, and an even smaller area with quailbrush as the chief phreatophyte. The phreatophytes in the northern half of Grass Valley occur as large healthy shrubs in various admixtures and densities, but dwindle to a scanty cover of greasewood and cottonthorn horsebush as overstory to shadscale and bud sagebrush in the southern part of the valley. There is little grass or forb understory to the greasewood, rabbitbrush or quailbrush stands. However, in the middle of the valley there are approximately 4,400 acres consisting predominantly of such phreatophytic grasses as saltgrass, alkali sacaton, and Great Basin wildrye. Scattered silver buffaloberry trees form an overstory to this grassland type; these trees are more prevalent in the southern end of the area.

The phreatophytes in Pumpernickel Valley vary from low density stands with widely distributed species, especially in the semi-playa bottomlands just south of Highway 40, to much higher density admixtures surrounding the bottomlands. The largest area in the sub-basin where rubber rabbitbrush is the dominant phreatophyte begins just west of Brooks

Photograph 19. - Shadscale-grass range in the fairly high forage production class, west side of Grass Valley, near the Pronto Plata Mine. Contrast the understory of perennial grasses in this photograph with the depleted understory of the low forage production class shadscale range pictured in photograph 6. FIELD PARTY PHOTO

Photograph 20. - Removal of the original sagebrush-perennial grass cover by fire, with the resultant invasion of practically worthless and highly inflammable cheatgrass, Winnemucca Mountain. The view is northward across the willow-fringed Humboldt Valley, immediately below Winnemucca. Cheatgrass is now the principal vegetal species in the extensive light-colored areas seen on the slopes of the mountain, delineating the bounds of the May 1958 burn. FIELD PARTY PHOTO 6-862-8

Table 1. -- Acreage of present and potential annual forage plant production classes, grouped by soil associations for each vegetal type and site, Sonoma Sub-Basin

Vegetal type and site	Present annual forage plant production classes (acres)			Potential annual forage plant production classes (acres)			Treatment needed to reach potential
1. Rabbitbrush-greasewood-grass; saline bottomlands	Production classes (pounds per acre) 1/			Production classes (pounds per acre) 1/			
Soil associations	850-1,500	200-900	20-300	850-1,500	200-900	20-300	
A1-R4	-----	-----	13,400	5,000	6,400	2,000	Brush removal by spraying or blading, streambank and channel stabilization, fencing, proper range management.
A2-A6-H2-R4	-----	-----	500	-----	500	-----	
A2-H2-A6	-----	-----	4,700	-----	4,700	-----	
A3-A9	-----	-----	2,900	-----	1,500	1,400	
A3-A9-H6	-----	-----	300	-----	300	-----	
A4-A6-H6-R4	-----	-----	5,000	2,500	2,500	-----	
A4-H1	-----	-----	600	-----	600	-----	
A5-A3-S2	-----	-----	10,600	5,000	5,600	-----	
A6-A13-H3	-----	-----	4,400	2,000	2,400	-----	
A6-H6-A13	-----	-----	14,800	2,000	7,800	5,000	
A13-A14-Y1-W1	-----	-----	10,000	3,000	5,000	2,000	
R4-A9	-----	-----	7,100	1,000	4,100	2,000	
S1-A3-D1	-----	-----	3,600	-----	2,000	1,600	
S1-A3-G1	-----	-----	4,200	-----	3,200	1,000	
S7-A8	-----	-----	500	-----	500	-----	
S2-A3	-----	-----	300	-----	300	-----	
Subtotal	-----	-----	82,900	20,500	47,400	15,000	
2. Semi-playa-greasewood-pickleweed; alkali bottomlands	Production classes (pounds per acre) 1/			Production classes (pounds per acre) 1/			
Soil associations	00000	00000	0-50	00000	00000	0-50	
A13-A14-Y1-W1	-----	-----	4,000	-----	-----	4,000	Proper range management.
Subtotal	-----	-----	4,000	-----	-----	4,000	
3. Meadow grasses-forbs-sedges; semi-wet meadows	Production classes (pounds per acre) 1/			Production classes (pounds per acre) 1/			
Soil associations	1,200-3,000	600-2,000	200-1,000	1,200-3,000	600-2,000	200-1,000	
A2-A6-H2-R4	-----	2,900	-----	2,900	-----	-----	Fencing, proper range management, and brush control where practical.
A2-H2-A6	-----	-----	600	-----	600	-----	
A4-A6-H6	-----	-----	800	800	-----	-----	
A5-A3-S2	-----	-----	1,900	-----	1,900	-----	
A6-A13-H3	-----	-----	600	-----	600	-----	
A6-H6-A13	-----	-----	3,100	1,500	1,600	-----	
S1-A3-D1	-----	200	-----	200	-----	-----	
Subtotal	-----	3,100	7,000	5,400	4,700	-----	

Continued

Table 1. -- Acreage of present and potential annual forage plant production classes, grouped by soil associations for each vegetal type and site, Sonoma Sub-Basin -- Continued

Vegetal type and site	Present annual forage plant production classes (acres)			Potential annual forage plant production classes (acres)			Treatment needed to reach potential
4. Shadscale-grass; droughty desert uplands	Production classes (pounds per acre) 1/			Production classes (pounds per acre) 1/			
Soil associations	100-350	50-150	10-70	100-350	50-150	10-70	
A1-R4	-----	-----	2,900	-----	1,500	1,400	Brush removal and seeding, selective
A3-A9	-----	-----	2,100	-----	500	1,600	spraying, stockwater development,
A3-A9-H6	-----	-----	1,000	-----	500	500	streambank and channel stabilization,
A6-H6-A13	-----	-----	600	-----	300	300	erosion-proofing of roads, intensify fire
B1-C1-R1-L1	-----	-----	400	-----	400	-----	protection, proper range management.
L1-B1	-----	-----	1,400	700	700	-----	
R1-L1-B1	-----	-----	6,800	3,000	3,800	-----	
R1-S8-B2-L1	-----	10,300	2,000	10,300	2,000	-----	
R4-A9	-----	-----	2,400	-----	1,200	1,200	
S1-A3-D1 (50-40-10)	-----	-----	13,200	-----	6,000	7,200	
S1-A3-D1 (40-40-20)	-----	-----	13,300	-----	6,000	7,300	
S1-A3-G1	-----	-----	12,200	5,000	5,000	2,200	
S1-G1-D1	-----	-----	20,200	-----	10,000	10,200	
S2-A3	-----	800	4,900	800	4,900	-----	
S2-D1 (80-20)	-----	2,200	1,800	2,200	1,000	800	
S2-D1 (60-40)	-----	1,300	9,700	1,300	5,000	4,700	
S2-G1	-----	2,600	16,400	5,000	11,000	3,000	
S5-A7-D1	-----	-----	11,200	2,000	2,000	7,200	
S6-A8-B2	1,200	-----	32,000	5,000	20,000	8,200	
S7-A2-G1	-----	-----	1,000	500	500	-----	
S7-A8	-----	-----	11,500	2,000	5,000	4,500	
S7-D1-G1	-----	-----	4,400	2,000	2,400	-----	
Subtotal	1,200	17,200	171,400	39,800	89,700	60,300	
5. Big sagebrush-grass; upland benches and terraces	Production classes (pounds per acre) 1/			Production classes (pounds per acre) 1/			
Soil associations	250-600	100-450	20-150	250-600	100-450	20-150	
A1-R4	200	2,100	17,900	5,000	9,300	5,900	Brush removal and seeding, selective
A2-S2-A10	-----	-----	20,900	15,000	5,900	-----	spraying, stockwater development,
A3-A9-H6	-----	-----	300	-----	300	-----	streambank and channel stabilization,
A4-A6-H6	200	-----	100	200	100	-----	erosion-proofing of roads, intensify fire
A4-H1	-----	-----	2,400	-----	1,200	1,200	protection, proper range management.
B1-C1-R1-L1	1,600	3,600	32,900	25,000	13,100	-----	
L1-B1	-----	-----	2,700	1,500	1,200	-----	
R1-B1-L12	-----	-----	6,000	3,000	3,000	-----	
R1-L1-B1	-----	-----	2,800	2,800	-----	-----	

Continued

Table 1. -- Acreage of present and potential annual forage plant production classes, grouped by soil associations for each vegetal type and site, Sonoma Sub-Basin -- Continued

Vegetal type and site	Present annual forage plant production classes (acres)			Potential annual forage plant production classes (acres)			Treatment needed to reach potential
5. (Continued)							
	Production classes (pounds per acre) 1/			Production classes (pounds per acre) 1/			
	250-600	100-450	20-150	250-600	100-450	20-150	
R4-A9	-----	-----	18,500	5,000	8,500	5,000	(See preceding page.)
R5-S3-L3	-----	-----	9,000	3,000	6,000	-----	
R6-B5-S2	-----	-----	4,000	2,000	2,000	-----	
R11-S8-B2	1,800	1,300	4,900	6,000	2,000	-----	
S1-A3-D1	-----	-----	10,600	4,000	5,000	1,600	
S1-A3-G1	1,800	500	16,100	15,400	1,500	1,500	
S1-G1-D1	-----	-----	2,800	-----	2,800	-----	
S1-R9	-----	-----	3,000	-----	3,000	-----	
S3-B5-G3	-----	1,400	8,300	5,000	4,700	-----	
S5-A7-D1	-----	-----	11,600	3,000	5,000	3,600	
S6-A8-B2	-----	400	26,400	3,000	20,400	3,400	
S6-B6-G1	-----	-----	13,000	5,000	6,000	2,000	
S7-A2-G1	-----	-----	12,000	8,000	4,000	-----	
S7-D1-G1	-----	-----	2,600	-----	2,600	-----	
Subtotal	5,600	9,300	228,800	111,900	107,600	24,200	
6. Low sagebrush-grass; claypan benches	Production classes (pounds per acre) 1/			Production classes (pounds per acre) 1/			
Soil associations	200-500	100-250	50-150	200-500	100-250	50-150	
R1-L1-B1	-----	-----	2,500	1,500	1,000	-----	Selective spraying, fencing, stockwater development, complete deferment of some areas for several years and permanent closure of critically damaged or unsuitable range, erosion-proofing of roads, proper range management.
R1-L1-B1-C1	-----	-----	7,000	5,000	2,000	-----	
R1-S8-B2-L1	-----	9,700	-----	9,700	-----	-----	
R6-B5-C1-L1	-----	-----	17,000	-----	10,000	7,000	
R13-L10-B1-C2	-----	-----	9,000	3,000	3,000	3,000	
Subtotal	-----	9,700	35,500	19,200	16,000	10,000	
7. Browse-aspen-grass; intermediate mountain slopes	Production classes (pounds per acre) 1/			Production classes (pounds per acre) 1/			
Soil associations	300-650	150-350	50-200	300-650	150-350	50-200	
B1-C1-R1-L1	-----	6,400	32,500	6,400	30,000	2,500	Selective spraying, fencing, stockwater development, complete deferment of some areas for several years and permanent closure of critically damaged or unsuitable range, erosion-proofing of roads, proper range management.
L1-B1	-----	-----	900	-----	900	-----	
R1-L1-B1	-----	-----	22,600	5,000	14,600	3,000	
R1-L1-B1-C1	-----	-----	8,300	2,000	4,300	2,000	
R13-L10-B1-C2	-----	-----	45,700	7,000	33,700	5,000	
S1-A3-D1	-----	-----	700	-----	700	-----	
Subtotal	-----	6,400	110,700	20,400	84,200	12,500	

Continued

Table 1. -- Acreage of present and potential annual forage plant production classes, grouped by soil associations for each vegetal type and site, Sonoma Sub-Basin -- Continued

Vegetal type and site	Present annual forage plant production classes (acres)			Potential annual forage plant production classes (acres)			Treatment needed to reach potential
8. Pinyon-juniper-grass; shallow stony slopes	Production classes (pounds per acre) 1/			Production classes (pounds per acre) 1/			
Soil associations	100-250	50-150	10-75	100-250	50-150	10-75	
B1-C1-R1-L1	-----	-----	2,600	1,600	1,000	-----	Brush removal and seeding, selective spraying, stockwater development, streambank and channel stabilization, erosion-proofing of roads, intensify fire protection, proper range management.
R1-L1-B1	-----	-----	1,200	-----	1,200	-----	
R13-L10-B1-C2	-----	-----	4,300	-----	4,300	-----	
S3-B5-G3	-----	-----	1,300	1,300	-----	-----	
Subtotal	-----	-----	9,400	2,900	6,500	-----	
9. Browse-aspen-conifer-grass; steep mountain slopes and basins	Production classes (pounds per acre) 1/			Production classes (pounds per acre) 1/			
Soil associations	350-800	200-500	75-250	350-800	200-500	75-250	
R1-L1-B1	-----	-----	3,100	3,100	-----	-----	Complete deferment on most of the area for several years, then fencing, stockwater development, streambank and channel stabilization, spraying on selected sites, proper range management.
R1-L1-B1-C1	3,800	2,900	-----	6,700	-----	-----	
R13-L10-B1-C2	-----	-----	29,000	-----	22,000	7,000	
Subtotal	3,800	2,900	32,100	9,800	22,000	7,000	
Total	10,600	48,600	681,800	229,900	378,100	133,000	

1/ These figures indicate total annual forage production (dry weight), and will be used as a basis for planning needs only. Forage production figures will not be used for assigning range carrying capacities. These carrying capacities will depend upon such factors as slope, soil depth, soil character and stability, and the management objectives of the administrative agency.

These rates represent production variance from poor years to good years. At higher elevations within the site, with greater precipitation the rates would be higher, and conversely for lower elevations.

Source: Humboldt River Basin Field Party.

Table 2. -- Phreatophyte acreage and average annual water use, Sonoma Sub-Basin 1/

	Species	Height class	Density	Acreage cropland	Acreage range types 2/	Annual ground water use 2/ (feet)	Annual ground water use 2/ (acre-feet)
Nonbeneficial	Willow	5-12'	.4-.6	-----	600	2.4	1,400
	Rose	4-8'	.2-.4	-----	200	1.5	300
	Silver buffaloberry	14-18'	.1-.4	-----	100	1.5	100
	Black greasewood	3'+	.03-.08	-----	9,900	.3	3,000
	Black greasewood	3'-	.03-.07	-----	23,400	.2	4,700
	Rubber rabbitbrush	3'+	.03-.08	-----	4,900	.3	1,500
	Douglas rabbitbrush	3'-	.03-.08	-----	1,500	.2	300
	Quailbrush	3'+	.07-.08	-----	800	.5	400
	Saltgrass	-----	.03-.15	-----	4,200	.5	2,100
	Seepweed	-----	.03-.07	-----	3,200	.5	1,600
	Cattail	4-8'	.05-.4	-----	50	6.0	300
	Bulrush	3-6'	.02-.2	-----	50	6.0	300
	Subtotal				48,900		16,000
Beneficial	Great Basin wildrye	-----	.04-.3	-----	1,400	1.0	1,400
	Creeping wildrye	-----	.02-.4	-----	4,500	1.0	4,500
	Alkali sacaton	-----	.03-.15	-----	2,200	.5	1,100
	Subtotal				8,100		7,000
	Wet meadow 3/	-----	-----	1,000	-----	.5	500
	Total			1,000	57,000		23,500

1/ These values in the table, when referred to in the text, are rounded.
2/ These values are based on natural stand densities and 100 percent composition, for each species, except for the irrigated and wet meadows.
3/ Mixture of Great Basin wildrye, creeping wildrye, sedges, and other grasses.

Source: Humboldt River Basin Field Party.

Spring in Pumpernickel Valley and extends north of Highway 40. In addition to these rabbitbrush stands, there are two small areas where either quailbrush or alkali sacaton are the dominant phreatophytes.

The majority of the stands where Great Basin wildrye and saltgrass are the dominant phreatophytes is located along the Humboldt River. Such phreatophytes as creeping wildrye, willow, and rose are also found here. Greasewood, interspersed with rubber rabbitbrush, big sagebrush, and cottonthorn horsebrush, generally forms a fringe to the Humboldt River bottomlands throughout the sub-basin. There is only a small amount of grass or forbs associated with these stands.

A minor area of cattails and bulrushes is found in the backwaters of the Humboldt River above the Stall diversion dam for the Diamond S Ranch, east of Golconda. Annual use of water is considered to be heavy, but because of the small area they occupy, their total consumption is negligible, compared to other water uses in the sub-basin. (See table 2.)

Timber Management

There are no commercial sawtimber stands within the sub-basin. The Bureau of Land Management has no program of commercial timber cutting on the public domain, as there are no stands of pinyon or mountain mahogany, or sufficiently large stands of commercially valuable juniper present. The thin, widely scattered stands of aspen are most valuable as protection types, or for their aesthetic value and shade.

The Bureau is presently investigating the possibility of establishing limited ponderosa pine plantings on suitable sites in the Sonoma Range. Toward this end, in 1963 a two-acre experimental planting was made in Water Canyon, which will be observed closely before additional stand establishment is attempted.

Fire Protection

Range fires in the immediate past have caused widespread watershed damage in the sub-basin, and remain an omnipresent threat. With deterioration or destruction of the original plant cover, whether brought about by fire or other watershed abuse, the vegetal types coming in increase the fire hazard by providing flash fuels. Fires on the steep, brush-covered, thin-soiled slopes of the Sonoma, Tobin, Osgood, and East Ranges, as well as Winnemucca Mountain, could be seriously damaging to these important watershed areas. (See photograph 20.)

Risks of fires caused by the rapidly increasing recreation and hunter use of the watershed lands will continue to mount. The significance of these water-yielding lands to the arid valleys below makes fire protection a factor of increasing importance. Prevention or prompt suppression of potentially disastrous range fires is now and will continue to be an important facet of resource and watershed management.

RECREATION AND WILDLIFE

Recreation Developments

Other than the partially developed picnic site at the mouth of Water Canyon, little progress has as yet been made toward a planned development of the Sonoma Sub-Basin's recreation potential. The area possesses some possibilities in this respect, particularly in the Sonoma Range canyons immediately south of Winnemucca. As the population buildup

in the Winnemucca area continues, and with fuller development of the largely untapped resource, the sub-basin's recreation potential will become more significant. This is true not only for the Sonoma Range, but also for the largely uninvestigated canyons on the Grass Valley side of the East Range.

In addition to camping, picnicking, hunting, and some fishing, the sub-basin possesses possibilities for hobby-type phases of recreation, such as rock collecting and Indian artifact hunting.

Public Domain

At present, there are no developed camp and picnic areas or other recreation improvements on these lands. The Winnemucca District has recently completed, in connection with the Outdoor Recreation Resource Review (ORRR), an inventory of camp and picnic sites in the Sonoma Range, adjacent to Winnemucca (see table 3). Further investigation for potential sites is planned, particularly in the East Range.

Wildlife

Deer and Other Big Game Hunting

Mule deer are common in the sub-basin. There are no well-defined deer herd migration routes from summer to winter range, and vice versa. With the onset of winter, the deer merely drop from their higher-altitude summer ranges to the winter ranges lower down in the same area. Approximately 150 deer are harvested annually from the sub-basin. Hunting pressure, mostly from local hunters, is heavy, because of the area's close proximity to Winnemucca and Lovelock.

So far as is known, range and watershed damages accruing from deer concentration and use in the sub-basin are minor. There is a marked lack of bitterbrush over the entire area, but whether this lack should be ascribed to past decimation from deer, livestock, or either, is not known.

Fisheries

The Humboldt River between Iron Point (Comus) and Rose Creek, once a prolific fishing stream, now provides only a limited fishery, because of: (1) extreme variation from year to year in water flows and temperatures; (2) tight dams and loosely controlled wild flooding irrigation methods; and (3) channel siltation, with its resultant elimination of fish food sources. However, the tailwaters below irrigation diversion dams do provide some sport fishing at present. The species of game fish most abundant in the tailwaters are channel catfish, black bullhead, large mouth bass, small mouth bass, blue gill sunfish, and white crappie.

A formal survey of the fishery along this section of the Humboldt River has not as yet been completed. No game fish were released along the Humboldt between Comus and Rose Creek during 1963; the amount of angler usage is not great on this section.

The fishery on the main Humboldt River could be improved considerably by maintenance of a continuous flow, elimination or alleviation of channel siltation, and elimination of pollution caused by domestic sewage. Also, poisoning of the undesirable carp would make way for re-establishment of the Humboldt River as an important fishable stream.

The angler usage on Clear, Sonoma, and Thomas Creeks during 1962 and 1963 was

Table 3. -- Potential developments, Outdoor Recreation Resource Review, 1962, public domain, Sonoma Sub-Basin

Site name and type of development	Acres 1/	Site devel. cost 2/ (dols.)	Access roads: Miles	Access roads: Construction cost (dols.)	Access roads: Rights of way acquisition cost (dols.)	Yearly camp maint. cost (dols.)	Trails: Miles	Trails: Devel. cost (dols.)	Water devel. cost (dols.)	Total devel. cost (dols.)	Area affected acres: BLM	Area affected acres: Other
Water Canyon camp and picnic site	4	21,600	--	----	----	900	--	----	Inc. in site dev. cost	21,600	200	--
Grand Trunk Spring camp and picnic site	3	16,200	1-1/2 mile ease- ment	----	----	350	--	----	Inc. in site dev. cost	16,200	80	--
Thomas Canyon camp and picnic site	4	21,600	--	----	----	900	--	----	Inc. in site dev. cost	21,600	640	--

1/ Calculated on the basis of three camp units per acre.

2/ At the rate of $1,800 per camp unit.

Source: Bureau of Land Management, Winnemucca District.

well below that recorded for previous years. This was primarily attributable to the destructive cloudburst in August 1961.

Thomas Creek was the only stream stocked during 1963 in the sub-basin. This stream received 520 pounds of fish, including brook and rainbow trout. The total number of trout released was 2,244.

Because of the severe deterioration of watershed conditions in this sub-basin, formerly fishable streams such as Clear Creek and Sonoma Creek are no longer the popular fisheries they once were. These streams cannot be expected to improve as fish habitats until there is a radical improvement in their watershed conditions. (See photographs 14, 15, 16, and 17.)

Pole Creek and Little Rock Creek drain into the Humboldt River from southwest of Golconda, and at present have fish populations sufficient for limited angler recreation. However, the channels of both these streams were badly washed during the dry-mantle flooding of August 1961, and were not stocked during 1962 or 1963.

Small Game

This sub-basin has within its boundaries some of the best small game hunting in Nevada. It is especially noted for its chukar hunting. This species is particularly abundant here, along with such less plentiful upland bird species as valley and mountain quail, sage grouse, and pheasants; waterfowl are scarce. Hunting pressure is heavy on the chukar, and light on the other upland birds. Cottontail rabbits are locally common, along the Humboldt and the larger stream bottoms.

PROGRAMS OTHER THAN PROJECT-TYPE DEVELOPMENTS AVAILABLE FOR THE IMPROVEMENT OF WATER AND RELATED LAND RESOURCES

Lands in the sub-basin can be treated or can receive aid for treatment under existing U.S. Department of Agriculture and other Federal and State programs. The Bureau of Land Management is responsible for range, recreation, and watershed developments on the Federal land it administers. The owners of private land can receive aid for water and related land resources development by means of various programs under the U.S. Department of Agriculture.

Technical Assistance and Cost-Sharing Under Public Law 46

Under the provisions of Public Law 46 the Soil Conservation Service furnishes technical assistance through Soil Conservation Districts, and the Agricultural Conservation Program of the Agricultural Stabilization Conservation Service provides cost-sharing. Under these programs, assistance in developing coordinated conservation plans and in applying conservation measures may be furnished for farms and ranches. These plans provide for surveys, land use adjustments, erosion control, water conservation, irrigation, drainage, flood prevention, and recreation development. Solution to the sub-basin problems on private land may be arrived at in part by these programs.

The Soil Conservation Service has the responsibility for leadership in the National Cooperative Soil Survey. With the assistance of several cooperative groups and agencies in this work, soils maps and survey reports will be published in the regular schedule of soil survey publications of the U.S. Department of Agriculture.

Agricultural Water Management

There are many ways of improving water management on individual ranches throughout the sub-basin. Some suggested treatments for various types of problems are listed below.

Problems	Suggested treatment
1. Limited water supply.	a. Develop irrigation water by drainage of seeps, springs and high water table. b. Control phreatophytic plant growth. c. Construct overnight storage reservoirs, to better utilize small flows for irrigation. d. Clear stream channels of all obstructions and install diversions with adequate control features. e. Install spreader ditches on fields that are flood-irrigated. f. Development of irrigation water wells where investigation reveals their feasibility. g. Line or seal ditches through reaches of excessive seepage loss. h. Irrigate each field only to the extent necessary to fill the root zone of the soil to field capacity.

Problems	Suggested treatment
2. Saline soils.	a. Install drains, to lower water table. b. Use only good quality water for irrigation, to reduce salt concentration in the soil. c. Use proper soil and water management practices.
3. High water table.	a. Install suitable drainage. b. Improve creek channels for drainage outlets, and to reduce frequent flooding of bottomland. c. Check the possibility for pump drainage. This may increase water supply for irrigation. d. Land smoothing to remove low ponding areas. e. Line and seal ditches. f. Irrigate each field only to the extent necessary to fill the root zone of the soil to field capacity.
4. Low-efficiency use of water.	a. Level or smooth land for even water application. b. Reorganize water distribution and irrigation systems. c. Line ditches through highly permeable soils. d. Irrigate each field only to the extent necessary to fill the root zone of the soil to field capacity. e. Plant high-yielding crops suitable for conditions, to reduce irrigated acreage now needed for hay production.
5. Inadequate water distribution systems.	a. Install diversions with adequate control features. b. Reorganize water distribution systems. c. Use lined ditches or pipe lines through highly permeable soils. d. Construct necessary control structures in ditches.

Vegetal Improvement

Widespread sheet erosion and severe stream bank cutting and channel erosion, particularly in the mountainous areas, indicate the need for action to reverse the trend toward land deterioration (see photographs 14 through 18). Each of the following solutions would contribute in some measure to the improvement of plant species and cover, which in turn will help reduce this erosion.

Problems	Suggested treatment
Irrigated Lands	
1. Low yields.	a. Establish higher-yielding forage crops suitable to the soil and water conditions, for hay and pasture. b. Use irrigation methods that will permit more efficient use of water and create an environment for higher-producing forage plants. c. Use proper soil and water management practices and adapted vegetal species, particularily on saline-alkali soils. d. Develop a fertilization program. e. Do not feed on wet fields.

Problems	Suggested treatment
Nonirrigated Lands	
1. Range condition static or on decline.	a. Develop a program of seeding and rehabilitation of suitable rangelands, or as replacement areas for seriously depleted critical watersheds unsuitable for grazing. b. Practice rotation-deferred grazing. c. Use bottomland pasture to supplement available range. d. Control low economic value plant growth to increase forage production. e. Control noxious and poisonous plant growth, for range betterment. f. Establish proper use practices. g. Fence, to enable better grazing control and proper range use. h. Improve salting and water distribution for better grazing control (see photograph 21).

Watershed Protection and Erosion Control

Except for the inaccessible, poorly watered, and fenced areas, which are relatively small compared to the total acreage, the range is generally in poor condition. The treatment required to reverse the condition trend in this area would include range seeding and spraying of sagebrush on selected sites, along with good range management, including proper use and deferred-rotation grazing.

Channel and gully erosion are very active throughout the sub-basin. Permanent type control structures and land treatment measures are needed to protect the stream channels. In addition, such practices as bank sloping, seeding of banks, and channel fencing along selected areas will help heal the erosion.

Photograph 21. - Stockwater reservoir built to improve cattle distribution and uniformity of grazing use through enhanced accessibility of previously unwatered range areas. FIELD PARTY PHOTO 6-837-11

The condition of the mountainous areas, particularly in the East and Sonoma Ranges, is such that grazing use should be deferred for several years, at least, or completely eliminated on critically depleted vital watershed areas. This may be accomplished by transferring the present use to adjacent suitable areas that can be seeded.

Possibilities for Water Salvage

Ground water use by phreatophytic plants was estimated to be about 23,500 acre-feet annually. This includes the water used by Great Basin wildrye and other wet-meadow species harvested for hay and pasture in the valley bottoms.

Phreatophytic plants of low economic value, such as willow, greasewood, rabbitbrush, wild rose, buffaloberry, quailbrush, cattail, bulrush, seepweed, and saltgrass use an estimated 16,000 acre-feet of water annually. More effort should be made to control or replace these water-consuming plants by chemical control, deep drainage, and blading. A large portion of this water could be salvaged or put to better use by the control or replacement of most of these water-wasting plants.

Bureau of Land Management Programs

Public Domain

The Bureau of Land Management is responsible for the administration and management of approximately 61 percent of the acreage in the Sonoma Sub-Basin. The Bureau's

range management program includes the proper use and improvement of the public domain. In addition, the Bureau is responsible for fire presuppression and control on the intermingled public and private lands it administers.

Adjudication of grazing privileges in this sub-basin has only begun. After the adjudications are completed and the allotments are fenced, management plans will be developed for each allotment, to insure proper use of the forage resources.

The soil and moisture program is integrated with the grazing program, and consists of stabilization and rehabilitation projects necessary to conserve soil, water, and closely related resources. The work also includes improvement of vegetation through natural revegetation, control of undesirable forage plants, seeding of more desirable plants, as well as soil surveys and hydrological studies on pilot watershed areas. The weed control program is designed to arrest the invasion and spreading of weed species which are poisonous or mechanically injurious to domestic livestock, or which threaten the agricultural economy of the area. Another facet of range and watershed management requiring immediate attention is the erosion-proofing or revegetation and retirement of old, abandoned, or low-standard roads, the contributory source of a considerable amount of washing, gullying and sedimentation. It is planned that the construction of all new roads will be done to proper standards and with adequate drainage.

Land classification, fire protection, and recreation are important phases of the Bureau of Land Management program. The long range land program includes the encouragement of land exchanges, in order to establish a more desirable land pattern, particularly on the higher watershed lands. The Bureau's proposed recreation development program is briefly outlined in table 3.

The public domain in the Sonoma Sub-Basin, along with intermingled private lands, provides summer and winter range for deer.

Fire Protection

The Winnemucca District of the Bureau of Land Management provides fire protection on the public domain and the intermingled private lands within the sub-basin. The following factors have helped or are needed to keep abreast of the increasing fire risks and hazards:

1. The introduction of new techniques, including more widespread and agressive fire protection, and improved fire prevention and patrol measures, commensurate with the increased public use.

2. More and better suppression equipment. The agencies concerned have established an air tanker base at Elko, to be used for the suppression of wild fires.

3. The recognition of high hazard areas from the study of past fire occurrence maps and fuel type maps, as well as keeping posted on new cheatgrass area buildups. Where possible, convert from high hazard species to lower fire danger cover.

4. Intensified and more diligent inspection and hazard elimination along the Southern Pacific and Western Pacific rights-of-way. Insist that railroads adhere closely to the Nevada fire laws with respect to fireproofing of diesel locomotives. Trucking firms and contractors using internal-combustion equipment should also be checked for compliance with this section of the fire laws.

5. Use of improved national fire danger rating systems.

6. Improved fire detection and radio communications.

7. Inclusion of cooperator ranch crews in Federal control organizations.

8. Hazard reduction in connection with road maintenance and recreation site development.

9. Increased cooperation by Humboldt and Pershing Counties with the Nevada Division of Forestry to provide better fire protection on the private lands.

WATERSHEDS WITH OPPORTUNITIES FOR PROJECT-TYPE DEVELOPMENT

The Watershed Protection and Flood Prevention Act (Public Law 566, 83d Congress, as amended) authorizes the Secretary of Agriculture to give technical and financial help to local organizations in planning and carrying out works of improvement in watershed or sub-watershed areas of 250,000 acres or less. These projects are for: (1) flood prevention; (2) agricultural phases of water management; (3) public recreational developments; and (4) other purposes, such as municipal and industrial water supplies, and improvement for fish and wildlife.

Project works of improvement include land treatment measures and individual structures having not more than 5,000 acre-feet of flood-water detention capacity, or not more than 25,000 acre-feet of capacity for all purposes.

Watershed projects provide a means for accelerating coordinated scheduling and installation of needed improvements on public and private lands.

The problems in at least one watershed - the Sonoma - in this sub-basin are such that they can best be handled on a project basis. Projects in this watershed would provide for watershed protection, flood control, municipal water supply, public recreation development, and reduce erosion.

Sonoma Watershed

The Sonoma Watershed is in the north-central part of the Sonoma Sub-Basin. It includes all the drainages from the Sonoma Range north of, and including, Clear Creek and Spanish Basin. There are approximately 227,000 acres within the proposed boundary.

Fifty-three percent of the land area is public domain, and 47 percent is privately owned. There are 340 acres administered by the Bureau of Indian Affairs for the Winnemucca Indian Colony, 20 acres of which are utilized for homesites.

It is proposed that an earth-fill dam be constructed across Water Canyon, primarily for flood control purposes. A preliminary investigation revealed one dam site which would require a structure 75 feet high and 1,100 feet long.

On Pole Creek, southwest of Golconda, an off-stream reservoir site, with a dam 30 feet high and 150 feet long, could be constructed primarily for irrigation and recreation use.

Land treatment measures would include improvements on some of the irrigated lands. In addition, many remedial measures and types of treatment are necessary to combat watershed deterioration and the accompanying reduction in range forage production, as well as to control or ameliorate flood danger.

The historic record of damages incurred in the City of Winnemucca from flood waters originating on Sonoma Mountain has fortunately not been high. However, the possibility of a storm striking the headwaters of Water Canyon and causing severe damage to the city appears to be great. This view is prompted by a review of the stream flow records of Pole Creek and Clear Creek; both drainages head on Sonoma Mountain. Record flows occurred in these two streams from a storm in August 1961, when measurements by the U.S. Geological Survey indicated 4,000 c.f.s. in Pole Creek and 11,400 c.f.s. in Clear Creek.

Big sagebrush is the predominant vegetal cover on the Sonoma Range, although patches and stringers of low and black sagebrush form the principal cover on the mountain tops and ridges. A mixture of shadscale and bud sagebrush covers the alluvial fans near the bottomlands in both Pumpernickel and Grass Valleys, and on the uplands near Little Rock and Pole Creeks.

About 96 percent of the watershed rangeland is in the low forage production class. The forage cover has been depleted to a point where the watershed is producing forage at approximately 20 percent of its potential.

Most of the moisture falls in the form of snow during the winter months; however, the area is subject to summer convection storms. Average annual precipitation varies from eight to 25 inches (elevations 5,000 to 9,400 feet). The gross water yield, computed for an 80 percent frequency flow from all drainages, would approximate 6,600 acre-feet. A large part of this water seeps into the alluvial fans and from there to ground water storage, where it is used by phreatophytic plants. The remainder is used for surface irrigation on about 1,900 acres of cropland. In addition, approximately 2,100 acres of cropland are irrigated from pumped wells in Grass Valley. The pumped water is considered to be supplied from unreplenished ground water storage; however, to date there has been no appreciable lowering of the water table or decrease in observed subsurface outflow.

One small area on private land in Water Canyon has been partially developed for picnic use. The Bureau of Land Management has plans to develop two sites for camp and picnic use: one in Water Canyon and one in Thomas Canyon.

A preliminary evaluation of the works of improvement proposed for this watershed is sufficiently favorable to warrant a more detailed study, to determine the feasibility of a project watershed.

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APPENDIX I

Pertinent elaborative material of value to the general reader, for his reference and guidance in the use of the sub-basin report.

CONTENTS

INITIATION OF ACTION
for
PROJECT-TYPE DEVELOPMENT

Accomplishing the Improvements, Public Law 566

The development of project operations would need to be initiated by a local sponsoring organization representing the landowners and operators. The sponsoring organization could initiate such action by submitting an application for watershed planning assistance to the Director of the State Department of Conservation and Natural Resources.

Under the provisions of the Watershed Protection Act, and the operations procedures as developed by the U.S. Department of Agriculture, a local sponsoring organization would provide needed land rights for structural improvements, and assume the responsibility for contracting the structural work and for its subsequent operation and maintenance.

The landowners would have responsibility for the installation of land treatment measures on the privately owned lands. Cost-sharing and credit assistance could be made available by the U.S. Department of Agriculture for such work.

The Bureau of Land Management would assume responsibility for the installation of land treatment measures on the Federal lands, which would be accomplished with the usual participation in costs by the range users.

Funds appropriated under the Watershed Protection Act can be made available to defray the cost of construction of the structural improvements for the reduction of floodwater and sediment damages, and to share in the construction cost of structural improvements for irrigation, drainage, fish and wildlife, and recreation development. These funds may also be used to provide cost-sharing assistance to local sponsors for the acquisition of land, easement and rights-of-way needed for public recreational developments. In addition, Public Law 566 funds are available for installing land treatment measures on Federal lands which are intended primarily for the improvement of vegetal cover (range seeding and brush-spraying).

SONOMA WATERSHED

Physical Features of the Watershed

Location

The Sonoma Watershed is in the north-central part of the Sonoma Sub-Basin. It includes all the drainages from the Sonoma Range north of, and including, Clear Creek and Spanish Basin.

Geology

Consolidated or largely consolidated sedimentary rocks of Paleozoic and Mesozoic ages are exposed or lie at shallow to moderate depths in the higher elevations of the Sonoma Range. They include quartzite, chert, argillite, sandstone, shale, slate, phyllitic shale, grit, limestone, and dolomite.

The range is flanked by piedmont slopes which are composed of alluvial fans or aprons formed by coalescent fans. In the northern part of Grass Valley the lower portion of the piedmont slopes merges with a lake plain. Along the north slope of the Sonomas, in the Pole-Little Rock Creek area, and in Pumpernickel Valley, these slopes either merge with the valley floor or terminate at scarps bordering the margin of the Humboldt River flood plain.

Grass Valley, below the Clear Creek confluence, and the Humboldt bottomland up to a few miles above Comus were inundated by the last deep-water stage of Lake Lahontan (elevation 4,380 feet). The beaches have been obscured by erosion and sedimentation; there are several prominent wave-cut terraces and scarps below this elevation. The Humboldt River in the Winnemucca area is presently entrenched from 20 to 55 feet in the lake sediments.

Soils

The soils in the Sonoma Range vary widely in depth to bedrock. They are mostly medium and gravelly medium textured, and well drained. Surface soils on the alluvial fans in the watershed area are complex, varying considerably in development because of age and erosional features; they have a poorly defined subsurface drainage pattern. The older soils at the top of the fans consist mostly of silt and clay. The younger soils down slope are made up of coarser grained material such as loam, sand, gravel, and cobble. These soil age groups are sometimes stratified, or they may be mixed. In general, the soils on the fans are moderately deep to deep, medium and gravelly medium textured, and moderately well to well drained. They have slight salt and alkali concentrations, and in some areas are underlain by a cemented pan.

The soils in the floodplains are generally deep lake and streamlaid sediments. They are mostly moderately fine to medium textured, poor to moderately well drained, and have salt and alkali concentrations ranging from none to strong. Sand dunes occur at the mouth of Grass Valley and in localized areas upstream along the Humboldt River. These dunes are mostly stabilized by plant cover in this area.

Vegetation

Big sagebrush is the predominant vegetal cover on the Sonoma Range (see photograph

Photograph 22. - Big sagebrush-grass range site on the sandhills between the Humboldt River and U.S. Highway 40, near the Winnemucca Airport (looking southeast). The range here, with its understory of perennial grasses and forbs, is in the fairly high forage production class. FIELD PARTY PHOTO 6-852-11

22). Patches and stringers of low and black sagebrush form the principal cover on the mountain tops and ridges. A mixture of shadscale and bud sagebrush covers the alluvial fans near the bottomlands in both Pumpernickel and Grass Valleys, and on the uplands near Little Rock and Pole Creeks.

Big sagebrush occupies approximately 60 percent of the watershed area; low and black sagebrush, 12 percent; and shadscale and bud sagebrush, 19 percent. The remaining nine percent consists of several types, including greasewood, rabbitbrush, juniper, a relict area of native grassland, cropland, and native meadow and hayland.

Cheatgrass and Sandberg bluegrass are presently the chief grasses associated with the sagebrush stands. On isolated or inaccessible north slopes, there are only a few relatively small areas where Idaho fescue, the pristine grass species at the higher elevations, is still the principal grass. Only scattered remnants of such climax plants as Great Basin wildrye or bluebunch wheatgrass are present throughout the watershed area.

Bitterbrush, a very desirable plant usually associated with big sagebrush and bluebunch wheatgrass and other climax plants, is scarce. Desert peach, which has little if any watershed or forage value, appears to have supplanted bitterbrush, and is undoubtedly increasing.

Arrowleaf balsamroot, buckwheat, groundsel, lupine, annual mustards, and milkvetch are the principal forbs present.

Climate

Precipitation gaging stations in and around the watershed area are listed under Precipitation in the sub-basin report. Records from these stations, and the water balance studies, indicate the average annual precipitation would vary between eight and 25 inches (elevations 5,000 to 9,400 feet). Most of the moisture falls in the form of snow during the winter months; however, the area is subject to summer convection storms.

The average frost-free period for the irrigated land (28 degrees F) is estimated to be 140 days.

Land Status and Use

The land status and use breakdown is as follows:

Land Status	Acres	Land use: Range land Acres	Range land %	Cropland Acres	Cropland %
Public Domain	120,000	120,000	53	-----	-
Winnemucca Indian Colony 1/	300	300	T	-----	-
Private	106,700	102,700	45	4,000	2
Total	227,000	223,000	98	4,000 2/	2

1/ Acreage is rounded. Total area is 340 acres; 20 acres are in homesites.
2/ 1963 acreage.

The private land is divided among an estimated 35 owners, excluding the ownership within the city limits of Winnemucca and the community of Golconda. Included in

the private land are about 8,700 acres owned by the Southern Pacific Land Company and 1,300 acres owned by California Pacific Utilities. The 4,000 acres of irrigated land are used to produce a variety of crops, including alfalfa, grain, and irrigated pasture.

Federal and private range lands are used for spring-fall, winter, and summer range for domestic livestock, as a year-long habitat for big game and other wildlife, and as a water production area.

Water Supply and Use

Sonoma Mountain is the primary source of water for irrigated land in the watershed. This supply is supplemented by water pumped from wells for croplands in Grass Valley. The annual water balance study indicates that the total gross water yield for an 80 percent frequency flow from all drainages would be approximately 6,600 acre-feet. It is significant from the ground water standpoint that the 50 percent frequency yield is 14,000 acre-feet (see Water Balance Studies, Appendix I). The maximum flow measured from Pole Creek was 4,000 c.f.s. in August 1961. During the same storm, Clear Creek flowed an estimated 11,400 c.f.s.

A large part of the runoff seeps into the alluvial fans to recharge ground water storage, and supply the water needs of 9,600 acres of phreatophytic plants. The remainder is used for surface irrigation on about 1,900 acres of cropland. There are a few storage ponds which furnish a small amount of water for livestock and wildlife use.

Ground Water

Ground water development at present consists of 25 irrigation wells, and three springs which were improved to obtain irrigation water. One spring has been developed in the mouth of Clear Creek, another at the top of the alluvial fan less than a mile south of Sonoma Creek, and the third on the Hot Springs Ranch in Pumpernickel Valley. There are a few small springs and seeps which have been developed for stockwater.

The wells are in Grass Valley, located in the valley bottom and near the toe of the alluvial fans. The water pumped comes from what is considered to be unreplenished ground water storage.

Water Use for Recreation Areas

At present there is one picnic area developed on private land in Water Canyon. The Bureau of Land Management has plans to develop two camp and picnic sites covering an estimated four acres each; one in Water Canyon, and another in Thomas Canyon. These three recreation areas will require a small amount of water use.

Watershed Problems

Agricultural Water Management

Generally, the problems on the irrigated lands concern the seasonal distribution of surface runoff, and the control and management of irrigation water.

Cropland is located along the Grass Valley bottomland and scattered along the alluvial fans at the mouths of the larger drainages in the watershed. Most of the normal annual runoff is dissipated by seepage into the alluvium. One reservoir site was found on

Pole Creek which could be developed for irrigation water storage. The other drainages were found to be too steep in most cases for economical storage development.

Flood Water, Erosion and Sediment Damage

The principal flood problems in the proposed Sonoma Watershed involve flood waters and sediment other than those resulting from Humboldt River flows. The problems here are primarily caused by flood damage or damage potential from four streams in the watershed area - Water Canyon (Cross Creek), Pole Creek, Sonoma Creek, and Clear Creek.

With respect to Cross Creek, a search of the newspaper files at Winnemucca and a house-to-house canvass along upper Lay and Bridge Streets in Winnemucca revealed that since 1932 there has been a total of three flooded basements from dry-mantle flows down Cross Creek. One of these floods occurred about 1932, one occurred in the 1940's, and the last in August 1961. In each instance, damage was minor, amounting to only a few hundred dollars for water removal and cleanup at each residence.

In the case of the Pole Creek drainage above Golconda, no specific record of flood damage could be found for the period between the disastrous Dutertre Dam break of May 1906 (see Flood Damage, sub-basin portion of this report) and the dry-mantle flooding of July 1913. This latter flood buried an automobile in mud and water on what is now interstate Highway 80, flooded houses in Golconda, and washed out a section of the Southern Pacific main line there. There was no record of extensive flood damage between 1913 and August 1961, when flooding Pole Creek caused some debris deposition along U.S. Highway 40, and plugged the Southern Pacific's diversion for its Golconda water supply.

The 1961 highway debris deposition was removed with less than a day's work by a Nevada Highway Department motor patrol grader. The damage to the railroad water supply system, upon which most Golconda residents depended for their culinary water, was more serious. To date, no repair work has been done (1965). Estimates of rehabilitation costs by the Southern Pacific for this diversion facility range from $1,000 to $2,000, depending upon the type of reconstruction carried out. As the railroad no longer has much need for a water supply at Golconda, it has done nothing to repair the 1961 damages, although pressed to do so by the affected Golconda residents.

Clear Creek, with its long record of dry-and wet-mantle flooding and heavy watershed damage (see the previously mentioned flood damage section), has not caused, in all its period of flooding, any appreciable damage to homes, ranch improvements, etc.

Sonoma Creek, which drains the southwest side of Sonoma Mountain, has evidently flooded many times in recent history, although the stream has never been gaged during flood periods, nor are there any recorded damages. However, there is evidence of severe erosion along the stream bottom. With increased expansion of the small tract subdivision on the alluvial fan below this drainage there would be a damage potential to this development.

The potential of disastrous flooding in the future is great for Clear Creek, Pole Creek, Cross Creek, and Sonoma Creek. This is particularly true for the Water Canyon (Cross Creek) area, where present residences and the probable expansion of the residential area in this section of Winnemucca would be directly and disastrously affected by any future flooding.

Calculations based upon maximum flows in Pole and Clear Creeks indicate a

potential of 2,200 c.f.s. in Cross Creek, which would be less than a one percent occurrence. (A one percent occurrence here is estimated to be 800 c.f.s.) Such a flow would greatly exceed the capacity of the culverts at street crossings in Winnemucca and would cause flooding and damage in the residential area. In addition, the California Pacific Utilities Company's auxiliary power plant for Winnemucca, located on lower Cross Creek in the vicinity of Minor Street, would be seriously jeopardized by floods of this potential.

Vegetation - Kind and Condition

Phreatophytes

The major phreatophyte areas in the watershed are located on the bottomlands in both Grass and Pumpernickel Valleys. These areas have a wide variety of phreatophytic species, both beneficial and nonbeneficial. Great Basin wildrye, creeping wildrye, saltgrass, alkali sacaton, greasewood, rabbitbrush, willows, and quailbrush are the principal species, and occur in various admixtures and densities.

The phreatophyte communities occupy approximately 16,000 acres of the watershed area and use an estimated 3,600 acre-feet of water. Because some of the species within this area are not phreatophytic, the acreage occupied by phreatophytes alone is estimated to be somewhat less (approximately 9,600 acres). About half of these phreatophytes are nonbeneficial, and it is estimated that 2,500 acre-feet of water might be salvaged by the removal of these stands. (See table 4.)

Range Forage Production

Table 5 presents information on the range forage production acreage, present and potential, for the Sonoma Watershed. Ninety-six percent of the watershed range land is in the low forage production class. The only area not in the low forage production class is on the east side of the watershed, south of Golconda. The principal vegetal species here are shadscale, black and bud sagebrush, with a scattered understory of such grasses as bottlebrush squirreltail, Indian ricegrass, and Sandberg bluegrass. These plant communities are close to the climax stage of plant succession for this range site.

In contrast, plant communities on the Sonoma Range have regressed far downward along the stages of plant succession, with big sagebrush and cheatgrass presently being the dominant plants. Very few climax species, such as bluebunch wheatgrass, Nevada bluegrass, Idaho fescue, bitterbrush, or Great Basin wildrye are to be found.

The Sonoma Range is characterized by steep slopes and narrow basins, with poor or undesirable vegetal cover and low plant density, and frequent rock outcrops and rock slide areas. These factors contribute to the rapid and erosive runoff which develops after intense summer convection storms, or the quick thawing of snow cover in the early spring.

It can be reasonably assumed that even with a climax plant cover on the Sonoma Range, the magnitude of the August 1961 storm would undoubtedly have been large enough to have produced high runoff on both Pole and Clear Creeks (see Water Supply and Use). However, it is also logical to assume that if the vegetal cover had consisted of climax plant species, with optimum plant vigor and density, the peak flow on both creeks would have been much less, and the destructive ravaging of the upper watershed slopes and creek channels would not have been so severe. (See photograph 23.)

The entire Sonoma Range in the proposed watershed area shows from moderate to severe signs of overuse and abuse. The plant cover has been depleted to a point where

the watershed is only producing forage at approximately 20 percent of its potential. It should be noted that the gravely deteriorated water retention capacity of the proposed watershed area, stemming from severe plant cover depletion, topsoil loss, and advanced stream channel degradation, makes it imperative that livestock use be based only upon those few and very limited swales, basins, and gentler slopes which are suitable and safe for grazing.

Photograph 23. - Depleted plant cover conditions on the watershed lands in the background of this photograph have been primary contributory factors in the resultant sheet, gully, and stream-channel erosion so evident here. Junction of north and south forks of Clear Creek, looking upstream (east). FIELD PARTY PHOTO 6-802-8

Table 4. -- Phreatophyte acreage and annual ground water use, Sonoma Watershed 1/

	Species	Height class	Density	Acreage cropland	Acreage range types 2/	Annual ground water use 2/ (feet)	Annual ground water use 2/ (acre-feet)
Nonbeneficial	Black greasewood	3'+	.03-.07	---	1,000	.3	300
	Black greasewood	3'-	.03-.06	---	3,000	.2	600
	Rubber rabbitbrush	3'+	.03-.07	---	1,400	.3	400
	Seepweed	---	.03-.07	---	1,000	.5	500
	Saltgrass	---	.04	---	1,800	.5	900
	Subtotal				8,200		2,700
Beneficial	Great Basin wildrye	---	.04	---	400	1.0	400
	Alkali sacaton	---	.04	---	1,000	.5	500
	Subtotal				1,400		900
	Wet meadow 3/	---	-----	200		.5	100
	Total	---	-----	200	9,600		3,700

1/ These values in the table, when referred to in the text, are rounded.
2/ These values are based on natural stand densities and 100 percent composition, for each species, except for the irrigated and wet meadows.
3/ Mixture of Great Basin wildrye, creeping wildrye, sedges, and other grasses.

Source: Humboldt River Basin Field Party.

Table 5. -- Acreage of present and potential annual forage plant production classes, grouped by soil associations for each vegetal type and site, Sonoma Watershed

Vegetal type and site	Present annual forage plant production classes (acres)			Potential annual forage plant production classes (acres)			Treatment needed to reach potential
1. Rabbitbrush-greasewood-grass; saline bottomlands	Production classes (pounds per acre) 1/			Production classes (pounds per acre) 1/			
Soil associations	850-1,500	200-900	20-300	850-1,500	200-900	20-300	
A1-R4	-----	-----	1,400	1,200	200	-----	Fencing, proper management and stocking, erosion-proofing of roads.
A3-A9	-----	-----	250	250	---	-----	
A3-A9-H6	-----	-----	250	-----	250	-----	
A5-A3-S2	-----	-----	9,900	5,000	4,900	-----	
A6-A13-H3	-----	-----	200	-----	200	-----	
A6-H6-A13	-----	-----	600	-----	600	-----	
Subtotal	-----	-----	12,600 2/	6,450	6,150	-----	
2. Meadow grasses-forbs-sedges; semi-wet meadows	Production classes (pounds per acre) 1/			Production classes (pounds per acre) 1/			
Soil associations	1,200-3,000	600-2,000	200-1,000	1,200-3,000	600-2,000	200-1,000	
A2-H2-A6	-----	-----	300	300	-----	-----	Fencing, selective spraying, stockwater development, proper management and stocking.
A5-H2-A6	-----	-----	2,000	2,000	-----	-----	
A6-H6-A13	-----	-----	3,000	3,000	-----	-----	
A6-A13-H3	-----	-----	300	300	-----	-----	
Subtotal	-----	-----	5,600 2/	5,600	-----	-----	
3. Shadscale-grass; droughty desert uplands	Production classes (pounds per acre) 1/			Production classes (pounds per acre) 1/			
Soil associations	100-350	50-150	10-70	100-350	50-150	10-70	
A3-A9-H6	-----	-----	1,500	-----	1,500	-----	Selective spraying, fencing, stockwater development, streambank and channel stabilization, erosion-proofing of roads, proper management and stocking.
A3-A9	-----	-----	1,600	-----	1,600	-----	
R1-S8-B2-L1	-----	5,700	400	6,100	-----	-----	
S1-A3-D1	-----	-----	7,100	2,000	5,100	-----	
S1-A3-G1	-----	-----	12,600	6,000	6,600	-----	
S2-A3	-----	700	5,200	4,900	1,000	-----	
S2-G1	-----	2,500	2,100	3,000	1,600	-----	
S5-A7-D1	-----	-----	3,600	1,000	2,600	-----	
Subtotal	-----	8,900	34,100	23,000	20,000	-----	

Continued

Table 5. -- Acreage of present and potential annual forage plant production classes, grouped by soil associations for each vegetal type and site, Sonoma Watershed -- Continued

Vegetal type and site	Present annual forage plant production classes (acres)			Potential annual forage plant production classes (acres)			Treatment needed to reach potential
4. Big sagebrush-grass; upland benches and terraces	Production classes (pounds per acre) 1/			Production classes (pounds per acre) 1/			
Soil associations	250-600	100-450	20-150	250-600	100-450	20-150	
A1-R4	-----	-----	8,300	6,000	2,300	-----	Brush removal and seeding, fencing, stockwater development, streambank and channel stabilization, erosion-proofing of roads, intensification of fire protection, proper management and stocking.
A3-A9-H6	-----	-----	300	300	-----	-----	
B1-C1-R1-L1	-----	-----	9,300	7,000	2,300	-----	
R6-B5-S2	-----	-----	4,200	4,200	-----	-----	
S1-A3-D1	-----	-----	8,900	4,100	4,800	-----	
S1-A3-G1	2,000	500	17,000	12,500	7,000	-----	
S5-A7-D1	-----	-----	5,400	3,400	2,000	-----	
S6-B6-G1	-----	-----	12,800	8,000	4,800	-----	
Subtotal	2,000	500	66,200	45,500	23,200	-----	
5. Low sagebrush-grass; claypan benches	Production classes (pounds per acre) 1/			Production classes (pounds per acre) 1/			
Soil associations	200-500	100-250	50-150	200-500	100-250	50-150	
R1-S8-B2-L1	-----	1,900	-----	1,900	-----	-----	Selective spraying, fencing, stockwater development, streambank and channel stabilization, erosion-proofing of roads, proper management and stocking.
R6-B5-C1-L1	-----	-----	16,700	10,000	6,700	-----	
R13-L10-B1-C2	-----	-----	9,200	6,000	3,200	-----	
Subtotal	-----	1,900	25,900	17,900	9,900	-----	
6. Browse-aspen-grass; intermediate mountain slopes	Production classes (pounds per acre) 1/			Production classes (pounds per acre) 1/			
Soil associations	300-650	150-350	50-200	300-650	150-350	50-200	
B1-C1-R1-L1	-----	-----	12,000	6,000	5,000	1,000	Streambank and channel stabilization, seeding, fencing, erosion-proofing of roads, intensification of fire protection, proper management and stocking, and stockwater development.
R13-L10-B1-C2	-----	-----	25,100	15,000	8,100	2,000	
S1-A3-D1	-----	-----	600	-----	600	-----	
Subtotal	-----	-----	37,700	21,000	13,700	3,000	
7. Pinyon-juniper-grass; shallow stony slopes	Production classes (pounds per acre) 1/			Production classes (pounds per acre) 1/			
Soil associations	100-250	50-150	10-75	100-250	50-150	10-75	
R13-L10-B1-C2	-----	-----	3,000	1,500	1,500	-----	Intensify fire protection, proper management and stocking, stockwater development, and selective juniper control
Subtotal	-----	-----	3,000	1,500	1,500	-----	

Continued

Table 5. -- Acreage of present and potential annual forage plant production classes, grouped by soil associations for each vegetal type and site, Sonoma Watershed -- Continued

Vegetal type and site	Present annual forage plant production classes (acres)			Potential annual forage plant production classes (acres)			Treatment needed to reach potential
8. Browse-aspen-conifer-grass; steep mountain slopes and basins	Production classes (pounds per acre) 1/			Production classes (pounds per acre) 1/			
Soil associations	350-800	200-500	75-250	350-800	200-500	75-250	
R13-L10-B1-C2	-----	-----	28,600	20,000	7,600	1,000	Fencing, streambank and channel stabilization, erosion-proofing of roads, contour trenching, seeding, gully plugs, intensification of fire protection, proper management and stocking.
Subtotal	-----	-----	28,600	20,000	7,600	1,000	
Total	2,000	11,300	213,700	140,950	82,050	4,000	

1/ These figures indicate total annual forage production (dry weight), and will be used as a basis for planning needs only. Forage production figures will not be used for assigning range carrying capacities. These carrying capacities will depend upon such factors as slope, soil depth, soil character and stability, and the management objectives of the administrative agency.

These rates represent production variance from poor years to good years. At higher elevations within the site, with greater precipitation the rates would be higher, and conversely for lower elevations.

2/ 2,200 acres phreatophytes in range sites 1 and 2 have been cleared for irrigation purposes, leaving approximately 16,000 acres total.

Source: Humboldt River Basin Field Party.

Opportunities for Development

Structural Measures

It is proposed that one earth fill dam be constructed in the Pole Creek drainage about six miles southwest of Golconda. A dam 30 feet high and about 150 feet long at its crest would require about 10,000 cubic yards of fill. This would be an off-stream site reservoir. The intake diversions from Pole Creek and the emergency spillway could be constructed in the upper end of the reservoir. The reservoir behind this dam would hold about 500 acre-feet of water.

The Pole Creek channel has a high seepage loss as it flows over the alluvial fan below the canyon. An increased flow for a longer period of time could be delivered to the point of use by installing a pipe line or some type of ditch lining through this section of high loss.

It is also proposed that an earth-fill dam be constructed across Water Canyon. One site that might be considered is about three miles southeast of Winnemucca. A dam at this site, 75 feet high and 1,100 feet long, would require about 400,000 cubic yards of fill. The reservoir behind this dam would have an estimated capacity of 500 acre-feet.

Land Treatment Measures

Irrigated Lands

There are an estimated 4,000 acres of cropland within the watershed boundaries. Improvement measures have been installed on some of the fields; however, additional treatment is needed. Improvements which can be made include land leveling and smoothing, reorganization of irrigation systems, installation of pipe lines or ditch lining, installing water control structures, and improvement of water management practices.

Watershed Protection and Improvement

Watershed deterioration and the accompanying reduction in range forage production noted under previous captions has not only damaged the watershed's hydrologic characteristics, but has damaged and imperiled the livestock industry itself, particularly on the Clear Creek drainage. Also, through the depletion of vegetal cover and topsoil loss on Pole Creek and Cross Creek, increasing flood danger has developed for habitations and structures at Winnemucca and Golconda in the flood paths emanating from these drainages.

The following actions and measures are considered the minimum necessary to improve watershed conditions and increase forage production:

1. Consolidate the public domain ownership pattern by a comprehensive land acquisition program for the intermingled private lands within the former railroad land grant.

2. Adjust domestic livestock and wildlife numbers to the available feed on range suitable for their use, as indicated by the allotment adjudication data.

3. In connection with item 2, construct the necessary distribution fencing, and develop all springs and seeps now undeveloped. Where feasible, institute deferred-rotation grazing on management units.

4. Eliminate livestock use on the steep, thinly vegetated and badly eroded slopes, high basins and snowbank areas around Sonoma Peak, at the heads of Pole Creek, Cross Creek, the north and south forks of Clear Creek, and in Spanish Basin.

5. Install erosion control structures (contour trenches) and seed the sparsely vegetated slopes at the heads of these drainages (approximately 1,200 acres in Pole Creek, 1,200 acres in Water Canyon, 2,000 acres in Spanish Basin, and 5,000 acres on the various forks of Clear Creek).

6. Install gully control structures and bleeder-type gully plugs at selected sites in the drainage heads of these streams.

7. Channel and streambank stabilization on approximately 12 miles of poor condition (Class 3) stream channel (see Channel Condition Classification Criteria, Appendix I). Do the necessary fencing to protect the work. This channel stabilization is urgently needed not only along approximately five miles of the two main forks of Clear Creek, but also for one-half mile in Cross Creek, two to three miles of the Pole Creek channel, and three miles of stream channel in Spanish Basin.

8. Treat all roads, in use or abandoned, to prevent or stop erosion. At least 20 miles of road are in need of treatment within the watershed. Of particular note are the roads in the north and south forks of Clear Creek, the Pole Canyon Road above and below the old Dutertre Dam site, and the primitive roads at the head of Water Canyon, on Cross Creek.

9. Revegetate to adapted species 42,000 acres of sagebrush lands on the upland bench and terrace site in the watershed. The implementation of this seeding program would aid the development of items 2 through 7 by enabling the transferral of livestock removed from unsuitable and depleted ranges to these rehabilitated areas.

10. Intensify fire protection.

Benefits Expected

Agricultural Water Management

Through better water use efficiency, increased yields of hay and forage crops not contributing additional surplus can be obtained from the croplands, with less soil erosion, after the installation of the proposed treatment measures.

Flood Control

The proposed flood control dam would offer protection to the City of Winnemucca from potential flood waters originating on Sonoma Mountain. In addition, this structure could be used as a head stabilization reservoir for a small standby power plant, and would provide an opportunity for recreation development.

Watershed Protection and Improvement

The land treatment and structural measures enumerated would result in better protection for the watershed, reduce erosion, at least partially restore desiccated meadowlands and eroded, washed-out stream bottoms, and reduce livestock management problems. In addition, these measures would benefit game species as well as livestock, and would reduce fire hazard. These benefits are reflected in terms of potential range forage improvement, as shown in table 5. It is estimated that the acreage of range land in the fairly high forage production class could be increased from the present 2,000 acres to 141,000 acres of useable range land area. There could be over a fourfold increase in terms of average pounds of useable forage produced, from the present yield of 10,200,000 pounds to 44,000,000 pounds potential yield.

Conclusion

A preliminary evaluation of the proposed works of improvement is sufficiently favorable to warrant a more detailed study, to determine the feasibility of a watershed project.

SOILS DESCRIPTION

The generalized soil survey of the Sonoma Sub-Basin shows the location and distribution of different kinds of soils by associations of Great Soil Groups. Each Great Soil Group includes a number of soils with similar internal development. Great Soil Groups mapped in the survey include:

Alluvial Soils (Symbol: A)

These are the soils that consist of essentially recent stream-laid deposits: alluvial fans, floodplains, terraces and basins. They have essentially no profile development, but a little organic matter may have accumulated. They are usually deep, stratified, variable with regard to drainage class, and occur under many different climates.

Brown Soils (Symbol: B)

These are the soils which have dark brownish A horizons about six inches thick, textural B horizons 10 to 15 inches thick, and calcareous parent material of variable thickness. Some of these soils have cemented calcium carbonate layers in the C horizon, and some may have the C horizon resting on bedrock. They are usually moderately deep to deep, well drained, and occur under a cool semi-arid climate with an average precipitation of 10 to 14 inches. Most of the Brown Soils in the Sonoma Sub-Basin occur at elevations above 5,000 feet, in the uplands.

Chestnut Soils (Symbol: C)

These soils have dark grayish brown to very dark grayish brown A horizons about six to eight inches thick, textural B horizons 10 to 15 inches thick, and parent material that may or may not be calcareous. These soils usually have darker A horizons, more organic matter, and have been more strongly leached than have the Brown Soils. The parent material may or may not rest on bedrock. They are usually moderately deep to deep, well drained, and occur in a cool semi-arid climate with an average precipitation of about 14 to 18 inches. Most of the Chestnut Soils in the Sonoma Sub-Basin occur at elevations above 5,500 feet, in the uplands.

Calcisols (Symbol: G)

These soils occur on highly calcareous parent material in the arid and semi-arid regions. They have developed where leaching is limited, but have formed under good to excessive drainage conditions. They include soils in which the calcium carbonate has accumulated to form a prominent Cca on Dca horizon near the lower depth of wetting. They have a light gray-brown A or A1 horizon, about 10 to 15 inches thick, which becomes lighter colored with depth. They are moderately deep, well drained, and occur with an average annual precipitation of about eight to 12 inches at elevations below 7,000 feet.

Desert Soils (Symbol: D)

These are well to imperfectly drained soils in a cool arid climate. They have a thin light-colored A horizon (less than six inches) that is neutral to mildly alkaline, low in organic matter, with platy structure and frequently vesicular porosity. The B horizon (six to 14 inches) usually contains more clay, and is as dark or darker than the A, is neutral to strongly alkaline, and may be calcareous. A layer of calcium-carbonate

accumulation, that may be cemented, occurs in or below the B horizon at a depth of one to three feet. They are moderately deep, medium and gravelly medium textured and occur in a four to eight inch precipitation zone.

Humic Gley Soils (Symbol: H)

These are the dark brown or black meadow soils that grade into lighter colored or rust-mottled grayish soil at depths of one to two feet. They are imperfectly to poorly drained, usually with seasonal fluctuating high water table, and occur along stream floodplains where they are subject to overflow. They occur in a cool semi-arid climate, and are found in the Sonoma Sub-Basin at elevations mostly below 6,000 feet.

Lithosols (Symbol: L)

These soils have an incomplete profile, or no clearly expressed morphology. They are shallow (less than 10 to 15 inches), and consist of freshly and imperfectly weathered masses of hard rock or hard rock fragments, and are largely confined to steeply sloping lands. In the higher rainfall areas of the sub-basin, some of these soils may have dark A horizons. They are usually excessively drained.

Regosols (Symbol: R)

These are soils which consist of deep unconsolidated deposits, in which few or no clearly expressed soil characteristics have developed. They are largely confined to colluvial accumulations on steep mountain slopes. Under eight to 10 inches of rainfall the Regosols may have only a weakly developed A horizon, while in higher rainfall areas they may have well developed dark A horizons six to 14 inches or more thick. In mountainous areas these soils may be underlain by bedrock 15 to 20 inches below the soil surface.

Sierozems (Symbol: S)

These are soils with a pale grayish or light brownish surface and textural B horizons closely related in color to the surface soil. They are usually calcareous in the B horizon, and frequently also in the surface soil. They quite often have a cemented calcium carbonate hardpan at shallow to moderate depths below the B horizon. The B horizon in the Sierozem Soils in this sub-basin is usually weakly developed and difficult to identify. In mountainous areas the Sierozems may be underlain by bedrock at moderate depths. These soils are found in a semi-arid cool climate, with an average annual precipitation of about eight to 10 inches, and mostly at elevations below 6,000 feet.

Solonchak Soils (Symbol: W)

These are saline, poorly to very poorly drained soils that are high in soluble salts at or near the surface. The A horizon is thin (less than four inches), light colored, and low in organic matter. They have no clearly expressed soil layers, and are usually associated with high water table. They are moderately deep to deep, medium and moderately fine textured, and occur in a five to eight inch precipitation zone.

Solonetz (Symbol: Y)

These are imperfectly drained soils with a very few inches of light grayish or brownish surface soil underlain by a hard columnar fine-textured horizon that is high in exchangeable sodium. They occur on floodplains, terraces, and some alluvial fans, usually as small areas associated with saline-alkali Alluvial Soils, Humic Gley Soils, and

Calcium Carbonate Solonchaks.

Mapping Units

Mapping units on the generalized soil survey map of the Sonoma Sub-Basin are associations of phases of Great Soil Groups that reflect characteristics of soils significant to use and management. Each mapping unit symbol includes the designation of approximate composition for each Great Soil Group that comprises the association.

Example: $\frac{\text{L1-C1-R1}}{\text{60-20-20}}$

SOILS TABLES

The following tables, 6 and 7, show the general soil characteristics and the interpretations for each Great Soil Group phase which was mapped in the sub-basin.

Table 6. -- Soil characteristics, Sonoma Sub-Basin

Soil Phase	Depth	Texture: Surface	Texture: Subsoil	Slope range %	Erosion	Salt & alkali	Drainage	Remarks
A1	Deep	Coarse to medium	Medium to moderately fine	2-8	Slight	None	Well to mod. well	10% blow-sand deposition
A2	Deep	Medium and gravelly medium	Medium	2-15	Slight 10% mod.	None	Well	50% stony soils, 10% seedable
A3	Moderately deep to deep	Medium	Medium	2-4	Slight 5% mod.	Slight	Well to mod. well	25% seedable
A4	Deep	Medium	Medium	0-2	Slight	Slight	Imperfect	Overflowed
A5	Deep	Medium	Medium	0-2	Slight	None to slight	Mod. well to well	10% overflowed, some gullying
A6	Deep	Medium to moderately fine	Medium to moderately fine	0-2	Slight	Moderate to strong	Imperfect to poor	
A7	Shallow to moderately deep	Medium to gravelly medium	Gravelly medium and medium	0-4	Slight 5% mod.	None	Somewhat excessive	Small areas suited to seeding
A8	Moderately deep to deep	Medium	Medium	2-8	Slight 10% mod.	None	Mod. well	20% stony soils
A9	Deep	Medium to moderately coarse	Medium to moderately coarse	0-10	Slight	Slight to moderate	Mod. well	May or may not have water table 6-10 ft., overblown with fine sand
A10	Deep	Medium	Medium	2-4	Slight 5% mod.	None	Well	Some areas suited for seeding
A13	Deep	Medium to moderately fine	Medium to moderately fine	0-2	Slight	Moderate to strong	Imperfect to mod. well	Occasionally overflowed
A14	Deep	Medium	Medium	0-2	Slight	None to moderately strong	Mod. well to well	10% mod. saline and alkali, occasionally overflowed
B1	Moderately deep to deep	Medium	Medium and moderately fine	30-50	Slight 15% mod.	None	Well	Hill creep
B2	Moderately deep to deep	Medium	Medium and moderately fine	4-15	Slight 5% mod.	None	Well	Small areas cropland, seedable

Continued

Table 6. -- Soil characteristics, Sonoma Sub-Basin -- Continued

Soil Phase	Depth	Texture: Surface	Texture: Subsoil	Slope range %	Erosion	Salt & alkali	Drainage	Remarks
B5	Moderately deep to deep over bedrock	Medium	Moderately fine and fine	10-50	Slight 10% mod.	None	Well	15% stony medium, 25% seedable
B6	Moderately deep over hardpan	Medium	Fine	3-10	Slight 5% sev.	None	Well	10% stony soils, 60% seedable
C1	Moderately deep to deep	Stony medium and medium	Medium to moderately fine	30-50	Slight 15% mod.	None	Well	10% very stony, 10% deep Chestnut soils
C2	Moderately deep to deep	Medium	Medium to moderately fine	4-15	Slight 10% mod.	None	Well	15-25% stony soils
D1	Moderately deep over gravels	Medium and gravelly medium	Medium and gravelly medium	0-4	Slight	None	Well	Some desert entry cropland
G1	Moderately deep over alkali soluable pan	Medium and gravelly medium	Medium and gravelly medium	3-10	Slight 20% mod. 10% sev.	None	Well	10% stony soils, 40% seedable
G3	Shallow	Gravelly and stony medium	Gravelly and stony medium	10-30	Moderate 10% sev.	None	Well	
H1	Deep	Medium	Medium	0-2	Slight	Slight	Imperfect	Overflowed
H2	Deep	Medium	Medium	0-2	Slight	None	Imperfect to poor	
H3	Deep	Medium to fine	Medium to moderately fine	0-2	Slight	Slight	Poor	Overflowed
H6	Deep	Medium and moderately fine	Medium and moderately fine	0-2	Slight	Slight to moderate	Imperfect to poor	Overflowed
L1	Shallow over bedrock	Stony and rocky medium		50-70	Slight 20% mod.	None	Excessive	10% rock outcrop
L3	Shallow over bedrock	Stony and rocky medium		30-50	Slight 15% mod.	None	Excessive	10% rock outcrop

Continued

Table 6. -- Soil characteristics, Sonoma Sub-Basin -- Continued

Soil Phase	Depth	Texture: Surface	Texture: Subsoil	Slope range %	Erosion	Salt & alkali	Drainage	Remarks
L10	Shallow over bedrock	Stony and rocky medium		30-60	Moderate 10% sev.	None	Excessive	10% rock outcrop
L12	Shallow over bedrock	Stony medium		16-30	Slight 5% mod.	None	Somewhat excessive	10% rock outcrop
R1	Moderately deep to deep	Stony and gravelly medium	Stony and gravelly medium	30-60	Slight 15% mod.	None	Somewhat excessive	
R4	Moderately deep to deep	Coarse	Coarse	2-7	Moderate	None to slight	Excessive	5% duneland
R5	Moderately deep to deep	Stony and gravelly medium	Medium	30-50	Slight 15% mod.	None	Somewhat excessive	
R6	Moderately deep to deep	Stony and gravelly medium	Medium	15-60	Slight 50% mod.	None	Well	
R9	Moderately deep to deep	Stony and gravelly medium	Medium	8-15	Slight 10% mod.	None	Well	5% rock outcrop
R11	Moderately deep to deep	Stony medium	Medium	40-60	Slight 10% mod.	None	Somewhat excessive	10% rock outcrop and very stony
R13	Moderately deep over bedrock	Stony medium	Stony medium	30-60	Moderate 10% sev.	None	Somewhat excessive	10% rockland
S1	Moderately deep to deep	Medium and gravelly medium	Medium to moderately fine	4-15	Slight 15% mod.	None	Well	Seedable, 20% stony soils
S2	Shallow to moderately deep	Medium and gravelly medium	Medium	2-8	Slight 20% mod.	None	Well	
S3	Moderately deep to deep	Stony medium	Medium	15-30	Slight 15% mod.	None	Well	
S5	Moderately deep to deep	Medium and gravelly medium	Medium	8-15	Moderate gullying 20% sev.	None	Well	20% stony soils
S6	Shallow to moderately deep	Medium with some rocks	Medium	8-30	Moderate gullying	None	Well	15% stony soils

Continued

Table 6. -- Soil characteristics, Sonoma Sub-Basin -- Continued

Soil Phase	Depth	Texture: Surface	Texture: Subsoil	Slope range %	Erosion	Salt & alkali	Drainage	Remarks
S7	Moderately deep to deep	Medium and moderately coarse	Medium and moderately coarse	2-8	Slight 15% mod.	None	Well	15% stony soils
S8	Moderately deep	Gravelly medium	Gravelly medium	20-40	Moderate	None	Well	10% stony soils
W1	Moderately deep to deep	Medium and moderately fine	Medium and moderately fine	0-2	Slight 20% mod.	Strong	Poor to very poor	Overflowed
Y1	Deep	Medium and moderately fine	Moderately fine to fine	0-3	Slight 5% sev.	Moderate to strong	Imperfect to moderately well	

Source: Humboldt River Basin Field Party.

Table 7. -- Interpreted soil characteristics, Sonoma Sub-Basin

Soil Phase	Precip. zone (inches)	Erosion hazard	AWHC 1/ (inches)	Soil Hydrologic Group	Capability subclass	Major land use	Dominant vegetation
A1	6-8	Slight	12	C	VIIs	Range	Big sage-grass
A2	6-8	Slight	8	B	VIc	Range	Big sage-grass
A3	6-10	Slight to moderate	10	C	VIIc	Range	Shadscale-budsage-squirreltail
A4	6-8	Slight	10	B	IIIw	Irrigated crops	Native meadow grasses and sedges
A5	6-8	Slight	9	C	IIw VIc	Irrigated crops and range	Rabbitbrush, sagebrush-greasewood-grass
A6	6-8	Slight	12	D	VIIs	Range and irrigated crops	Greasewood-saltgrass, rabbitbrush-saltgrass
A7	6-10	Moderate	3	B	VIIs	Range	Big sage-grass
A8	6-10	Moderate	12	B	IIw VIc	Range	Big sage-grass
A9	6-10	Slight	8	B	VIIs	Range	Greasewood-rabbitbrush, budsage, shadscale, cheatgrass
A10	6-8	Slight to moderate	12	C	VIIc	Range	Winterfat-budsage, Indian ricegrass
A13	6-8	Slight	12	D	IVw VIIs	Range, native pasture, cropland	Greasewood-saltgrass
A14	6-8	Slight	10	B	VIc	Range	Big sage-grass, rabbitbrush-grass
B1	7-25	Moderate	4	C	VIIe	Range	Big sage-grass
B2	6-10	Moderate	6	C	VIc	Range	Big sage-grass
B5	8-25	Slight	6	C	VIIs	Range	Big sage-grass
B6	6-10	Slight	6	C	VIs	Range	Big sage-grass
C1	8-25	Moderate	6	C	VIIe	Range	Big sage-bitterbrush-grass
C2	8-25	Moderate	8	C	VIc	Range	Big sage-grass
D1	6-10	Slight	4	D	VII	Range, cropland	Shadscale-budsage
G1	6-10	Moderate	5	D	VIc	Range, cropland	Big sage-grass
G3	8-10	Slight	3	D	VIIs	Range and woodland	Big sage-grass, juniper-grass
H1	6-8	Slight	12	B	VIIs	Range	Big sagebrush, greasewood, saltgrass

Continued

Table 7. -- Interpreted soil characteristics, Sonoma Sub-Basin -- Continued

Soil Phase	Precip. zone (inches)	Erosion hazard	AWHC 1/ (inches)	Soil Hydrologic Group	Capability subclass	Major land use	Dominant vegetation
H2	6-8	Slight	12	B	IIw	Meadow hayland and pasture	Meadow grass
H3	6-8	Slight	10	D	IIIw	Meadow hayland and pasture	Meadow grass
H6	6-10	Slight	10	B	IVw VIw	Range and meadow	Rabbitbrush, giant wildrye, saltgrass
L1	6-25	Moderate	1.5	D	VIIs	Range and watershed	Low sage-grass
L3	8-10	Moderate	1.5	D	VIIs	Range	Low sage-grass
L10	8-25	Severe	1.5	D	VIIs	Range and watershed	Low sage-grass
L12	7-10	Slight	1.5	D	VIIs	Range and watershed	Big sage-grass, low sage-grass
R1	6-20	Moderate	6	C	VIIe	Range and watershed	Big sage-grass, bitterbrush
R4	6-8	Moderate	6	A	VIIs	Range, cropland	Rabbitbrush, spiny hopsage, grass
R5	8-10	Moderate	6	C	VIIe	Range	Big sage-grass
R6	10-25	Moderate	4	C	VIIe	Range	Big sage-grass
R9	6-8	Moderate	6	C	VIIe	Range	Big sage-grass
R11	8-10	Moderate	7	C	VIIe	Range	Big sage-grass
R13	8-12	Severe	4	C	VIIe	Range	Big sage-grass, mixed browse
S1	6-10	Slight to moderate	6	C	VIc	Range 75%	Big sage-grass, shadscale
S2	6-10	Moderate	3	D	VIIs	Range	Shadscale-budsage-grass
S3	8-10	Moderate	4	C	VIIe	Range	Big sage-grass, spiny hopsage
S5	6-10	Moderate	4	C	VIc VIIc	Range, small areas seedable	Big sage-grass
S6	6-10	Moderate	4	D	VIIs	Range	Shadscale-budsage
S7	6-8	Moderate	5	C	VIc	Range	Big sage-grass, spiny hopsage
S8	6-10	Slight	4	D	VIIe	Range	Big sage-grass
W1	6-8	Moderate	5	D	VIIs	Range	Greasewood-saltgrass
Y1	6-8	Slight	12	D	VIIs	Range	Greasewood-saltgrass

Source: Humboldt River Basin Field Party.

DEFINITIONS

HYDROLOGIC SOIL GROUPS

Watershed soil determinations are used in the preparation of hydrologic soil cover complexes, which in turn are used in estimating direct runoff. Four major soil groups are used. The soils are classified on the basis of intake of water at the end of long-duration storms occurring after prior wetting and opportunity for swelling and without the protective effects of vegetation.

Group A - Soils having high infiltration rates even when thoroughly wetted, consisting chiefly of deep, well to excessively well drained sand or gravel. These soils have a high rate of water transmission and would result in a low runoff potential.

Group B - Soils having moderate infiltration rates when thoroughly wetted, consisting chiefly of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission.

Group C - Soils having slow infiltration rates when thoroughly wetted, consisting chiefly of (1) soils with a layer that impedes the downward movement of water, or (2) soils with moderately fine to fine texture and slow infiltration rate. These soils have a slow rate of water transmission.

Group D - Soils having very slow infiltration rates when thoroughly wetted, consisting chiefly of (1) clay soils with a high swelling potential; (2) soils with a high permanent water table; (3) soils with a claypan or clay layer at or near the surface; and (4) shallow soils having a very low rate of water transmission.

LAND USE CAPABILITY CLASSES AND SUBCLASSES

The capability classification is a practical grouping of soils. Soils and climate are considered together as they influence use, management, and production on the farm or ranch.

The classification contains two general divisions: (1) land suited for cultivation and other uses; and (2) land limited in use and generally not suited for cultivation. Each of these broad divisions has four classes which are shown by a number. The hazards and limitations in use increase as the class number increases. Class I has few hazards or limitations, or none, whereas Class VIII has a great many.

Capability classes are divided into subclasses. These show the principal kinds of conservation problems involved. The subclasses are "e" for erosion, "w" for wetness, "s" for soil, and "c" for climate.

Capability classes and subclasses, in turn, may be divided into capability units. A capability unit contains soils that are nearly alike in plant growth and in management needs.

Land Suited for Cultivation and Other Uses

Class I — Soils in Class I have few or no limitations or hazards. They may be used safely for cultivated crops, pasture, range, woodland or wildlife.

Class II — Soils in Class II have few limitations or hazards. Simple conservation practices are needed when cultivated. They are suited to cultivated crops, pasture, range, woodland, or wildlife.

Class III — Soils in Class III have more limitations and hazards than those in Class II. They require more difficult or complex conservation practices when cultivated. They are suited to cultivated crops, pasture, range, woodland, or wildlife.

Class IV — Soils in Class IV have greater limitations and hazards than Class III. Still more difficult or complex measures are needed when cultivated. They are suited to cultivated crops, pasture, range, woodland, or wildlife.

Land Suited for Range and Other Uses

Class V — Soils in Class V have little or no erosion hazard, but have other limitations that prevent normal tillage for cultivated crops. They are suited to pasture, woodland, range or wildlife.

Class VI — Soils in Class VI have severe limitations or hazards that make them generally unsuited for cultivation. They are suited largely to pasture, range, woodland, or wildlife.

Class VII Soils in Class VII have very severe limitations or hazards that make them generally unsuited for cultivation. They are suited to grazing, woodland, or wildlife.

Class VIII Soils and land forms in Class VIII have limitations and hazards that prevent their use for cultivated crops, pasture, range, or woodland. They may be used for recreation, wildlife, or water supply.

ANNUAL WATER BALANCE STUDY - 80 PERCENT FREQUENCY (CHANCE)

Annual water balance, as used in these studies, is the evaluation of a portion of the hydrologic cycle. The cycle starts with incident precipitation on the watershed, and ends with the runoff, both surface and subsurface flow, after subtracting water uses and losses. The term balance in the title of these studies is not intended to indicate that the results of the studies are exactly coincident with the stream gage readings. A full agreement would require minute manipulations of the factors used in the calculations. A true balance was made at a few key gages on small watersheds to check the procedure and the accuracy of the factors used in the computations.

The annual water balance was calculated for an 80 percent frequency (expected to be equaled or exceeded eight out of 10 years). This frequency was used because normally such a water supply would be the quantity needed to justify land and irrigation improvements on ranches growing high-yielding forage crops. In drainages such as Grass Valley, however, the 80 percent frequency concept has only limited value in defining the total available water supply. The quantity of ground water in storage in Grass Valley, estimated by the U. S. Geological Survey to be 1,500,000 acre-feet, is large in relation to yield. The usable water supply for any year would therefore approach the average annual yield.

Values obtained using this procedure are approximations. Accuracy would depend on the reliability of the basic soils, vegetation, and hydrologic data used, and would normally be in the range of 60 to 90 percent.

Except for Pole Creek, water yield data are not available on the watersheds in the Sonoma Sub-Basin. U.S. Geological Survey streamflow records for seven years (1957-1963) at the Pole Creek gage were used to estimate the 80 percent discharge from that drainage. Stream gage records at the Comus and Rose Creek stations were used to check the water uses and losses in the Humboldt reach.

The available information used for determining precipitation in the watershed areas consisted of four recording stations, eight storage gages, and one cooperative snow survey course (see Precipitation, this report). These data give an indication of the annual precipitation. The precipitation used in the water balance studies was determined as the quantity needed to produce the 80 percent frequency (chance) flow, after subtracting the water uses and losses.

The flow from all springs was assumed to be part of the gross water yield (estimated available water prior to agricultural and phreatophytic uses) from the sub-basin.

A flow diagram of water yields and depletion, with quantities in acre-feet, is shown in figure 1. Table 7 is a summary of the water balance studies by elevation zones for watersheds. The difference in water yield, inches per acre, is caused by the difference in watershed characteristics. These characteristics include (1) precipitation; (2) soil development; (3) condition and species of plant cover; and (4) physical features of the drainage (exposure, topography, slope, etc.).

In Grass and Pumpernickel Valleys, these studies indicate that the annual water requirements for irrigation and phreatophytic growth, plus the subsurface outflow to the Humboldt River, are greater than the estimated gross water yield as frequently as seven to eight years out of 10. It is assumed that the additional water required for these purposes is available from the ground water storage. Based upon the more or less consistent quantity of water used and lost, and which outflows to the Humboldt from year to year, it is

assumed that the ground water storage remains in balance over a cycle of wet and dry years; when available water supply exceeds use and loss (two to three years out of 10) a major part of the excess recharges the ground water storage.

A study of the subsurface flows and ground water storage is beyond the scope of this study. It is necessary in this type of study to attempt a water budget between the water yield and the discharge at a stream gage for a given frequency of occurrence. In Grass Valley and the area designated as Pole-Little Rock Creek Watershed, the amount of water used by irrigated crops and phreatophytes would only increase slightly with an increase in water yield. A greater portion of the increased yield would either flow into the Humboldt as surface flow or recharge the ground water reservoir and discharge as subsurface flow. A lag in time between infiltration after precipitation and outflow as subsurface flow would tend to lessen this discharge fluctuation from year to year.

The annual water balance inventories by watersheds were made to find answers to the following questions:

1. What is the gross water yield of the watersheds in the sub-basin? Gross water yield, for the purpose of this study, is the estimated available water, both surface and subsurface, prior to agricultural and phreatophytic use. Generally, this water yield is estimated for a stream or streams at a point above the highest diversion for the main body of irrigated land on a flood plain of a valley.

2. What is the magnitude of water use and loss by each of the major ground cover types?

3. Where are the water-yielding areas in the sub-basin and in each watershed?

4. Can vegetal manipulation be used to increase water supply for beneficial use?

The sub-basin was divided into four watersheds, in order to obtain a more accurate estimate of water yield, water uses and losses. They are: (1) Pumpernickel Valley; (2) Pole-Little Rock Creeks; (3) Grass Valley; and (4) Comus to Rose Creek (see sketch map, figure 2).

The results of the water balance studies indicate the following:

1. The 80 percent gross water yield (surface and subsurface) from the sub-basin was estimated to be 10,400 acre-feet.

2. The estimated surface and ground water uses and losses are as follows:

	Acres	Water use acre-feet
Irrigated crops	13,000	15,000
Phreatophytes	57,000	23,000
Direct evaporation from surface water	------	4,500
Municipal water	------	500
Total		43,000

3. The drainages from the Sonoma Range contribute over 70 percent of the water yield in the sub-basin.

4. Phreatophytes of low economic value, consisting of willow, wild rose, greasewood, rabbitbrush, saltgrass, buffaloberry, quail-brush, cattail, bulrush, and seepweed, use an estimated 16,000 acre-feet of water. A large part of this water could be put to beneficial use by controlling or replacing some of these water-wasting plants.

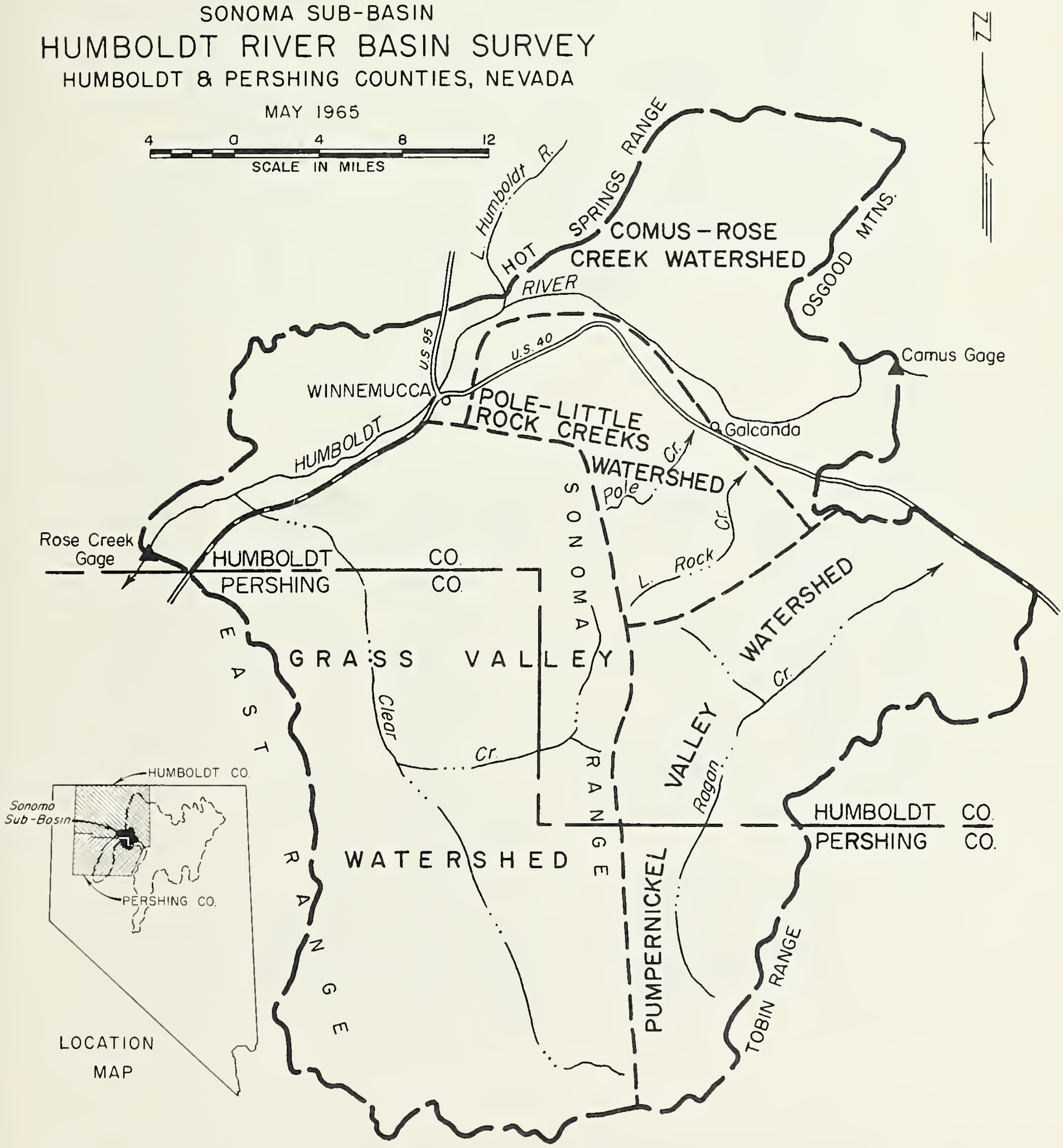

Figure 2. -- Watersheds delineated for water balance studies, Sonoma Sub-Basin.

Table 8. -- Summary of Water Balance Studies by elevation zones for watersheds in Sonoma Sub-Basin for an 80 percent frequency (chance)

Elevation zone (feet)	Pumpernickel Valley			Pole-Little Rock Creeks		
		Water Yield			Water Yield	
	Acres	in./ac.	acre-feet	Acres	in./ac.	acre-feet
8,000-9,400	1,000	3.72	310	2,000	7.44	1,240
7,000-8,000	4,000	1.32	440	4,800	2.95	1,180
6,000-7,000	16,900	.48	670	12,600	.55	580
5,000-6,000	60,800	.02	100	39,300	.01	40
4,200-5,000	69,300	---- (-)	20	26,300	---- (-)	40
Total	152,000		1,500	85,000		3,000
Gross Water Yield:			1,500			3,000
Inflow:			-----			-----
Uses and losses:						
Irrigated crops		(200 ac.) (-)	200		(650 ac.) (-)	700
Phreatophytes		(14,800 ac.) (-)	5,100			---
Direct evaporation from surface water			-----			-----
Municipal water			-----			-----
Use and outflow from ground water storage			3,800			3,000
Outflow:			None	To Humboldt River		5,300

Continued

Table 8. -- Summary of Water Balance Studies by elevation zones for watersheds in Sonoma Sub-Basin for an 80 percent frequency (chance) -- Continued

Elevation zone (feet)	Grass Valley: Acres	Grass Valley: Water Yield in./ac.	Grass Valley: Water Yield acre-feet	Comus to Rose Creek: Acres	Comus to Rose Creek: Water Yield in./ac.	Comus to Rose Creek: Water Yield acre-feet
8,000-9,400	3,000	4.24	1,060	---	----	---
7,000-8,000	14,000	1.84	2,150	900	1.47	110
6,000-7,000	51,700	.52	2,230	5,100	.64	270
5,000-6,000	102,500	.02	210	27,700	.04	100
4,200-5,000	166,800	----	(-) 150	145,300	----	(-) 80
Total	338,000		5,500	179,000		400
Gross Water Yield:			5,500			400
Inflow:			-----	Humboldt River at Comus		74,500
				Pole-Little Rock Creek		5,300
				Little Humboldt		3,000
				Grass Valley		5,000
Uses and losses:						
Irrigated crops	(4,000 ac.)	(-)	5,000	(8,150 ac.)	(-)	9,100
Phreatophytes	(20,500 ac.)	(-)	6,900	(21,600 ac.)	(-)	11,000
Direct evaporation from surface water			-----		(-)	4,500
Municipal water			-----		(-)	500
Use and outflow from ground water storage			11,400			-----
Outflow:	To Humboldt River		5,000	Humboldt River at Rose Creek		63,100

Source: Humboldt River Basin Field Party.

FOREST SERVICE REGION FOUR
CHANNEL CONDITION CLASSIFICATION CRITERIA

The following describes a method of classifying the condition of perennial or intermittent stream channels. Channel condition, as used here, is measured by indicators of channel stability. Classification is not based on any one factor; all the criteria must be weighed before a decision is reached.

Class 1 - Good

1. Channel sides well vegetated.
2. No slumping of channel sides.
3. Very little or no cutting or deposition of channel bottom.
4. Aquatic vegetation on channel sides and bottom.
5. Algae on rocks.
6. Very little or no recent cutting or deposition along channel sides.

Class 2 - Fair

1. Channel sides partially vegetated.
2. Slumping of channel sides at constrictions and bends.
3. Some cutting of channel bottom at constrictions, bends and steep grades and deposition in areas where the water velocity is less, e.g. pools.
4. Aquatic vegetation scattered, mostly in areas where stream velocities are low.
5. Algae on rocks in places where the bottom is stable.
6. Some cutting of stream banks at constricted areas or at outside of bends; deposition at the inside of bends and at the confluence with other streams.

Class 3 - Poor

1. Very little vegetation on channel sides.
2. Slumping of channel sides common.
3. Cutting and deposition of channel bottom common, bottom obviously in a state of flux.
4. No aquatic vegetation.
5. No algae on rocks.
6. Large-scale cutting of stream banks common.

Channels in Rock

In some instances, the channel cross section may be carved in rock. In this case, some of the factors listed under the Fair or Poor class may be in evidence, e.g., lack of vegetation on banks and deposition at grade changes. In order to classify the condition of such channels on the basis of channel stability, they must be considered to be in the Good condition class.

APPENDIX II

This appendix is produced in a relatively limited number of copies. It contains material germane to the Sonoma Sub-Basin but which, because of its detailed or technical nature, is not attached to copies for general distribution.

Such material, however, has potential value as an information reservoir for technicians, administrators, and resource managers concerned with the Sonoma Sub-Basin.

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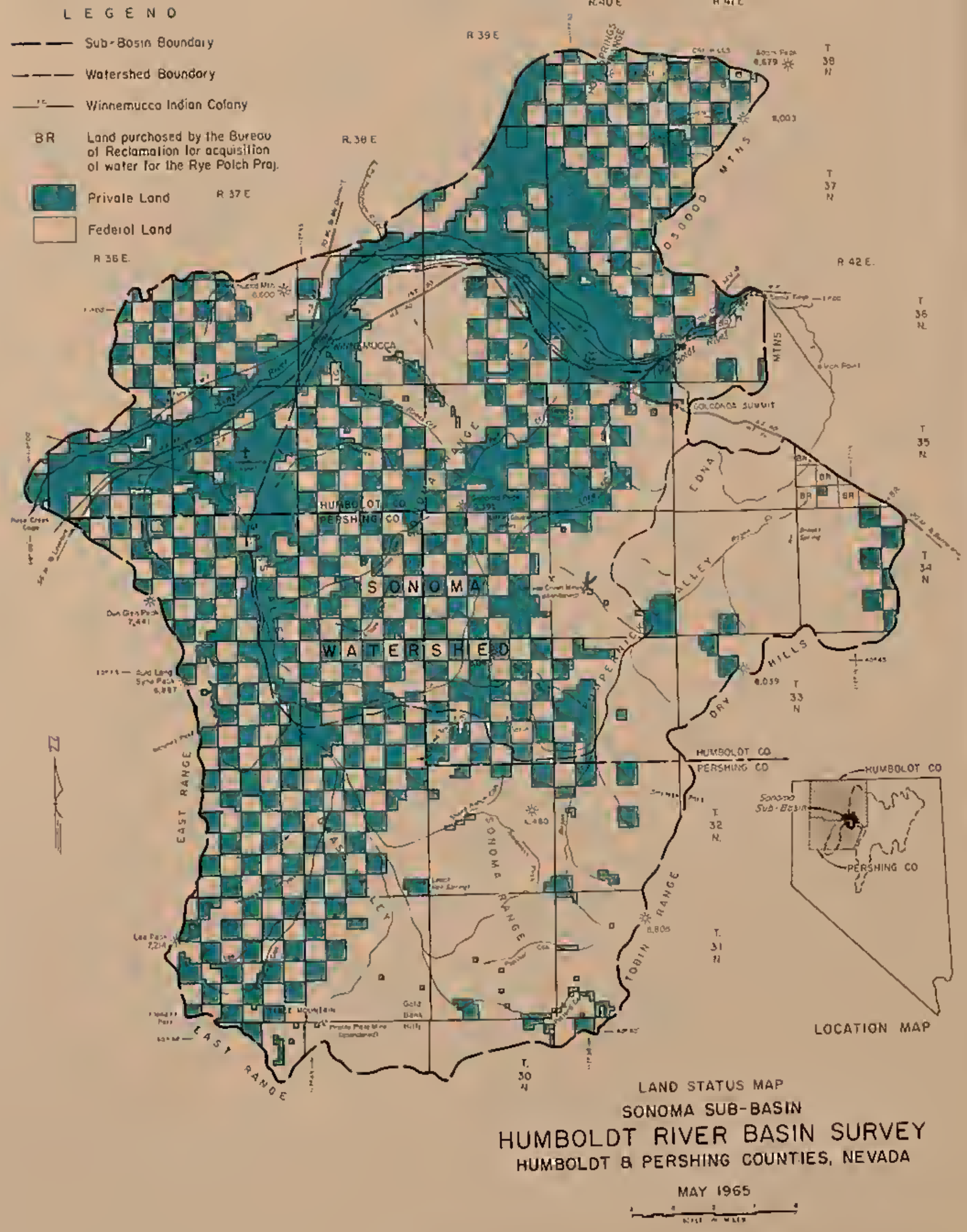
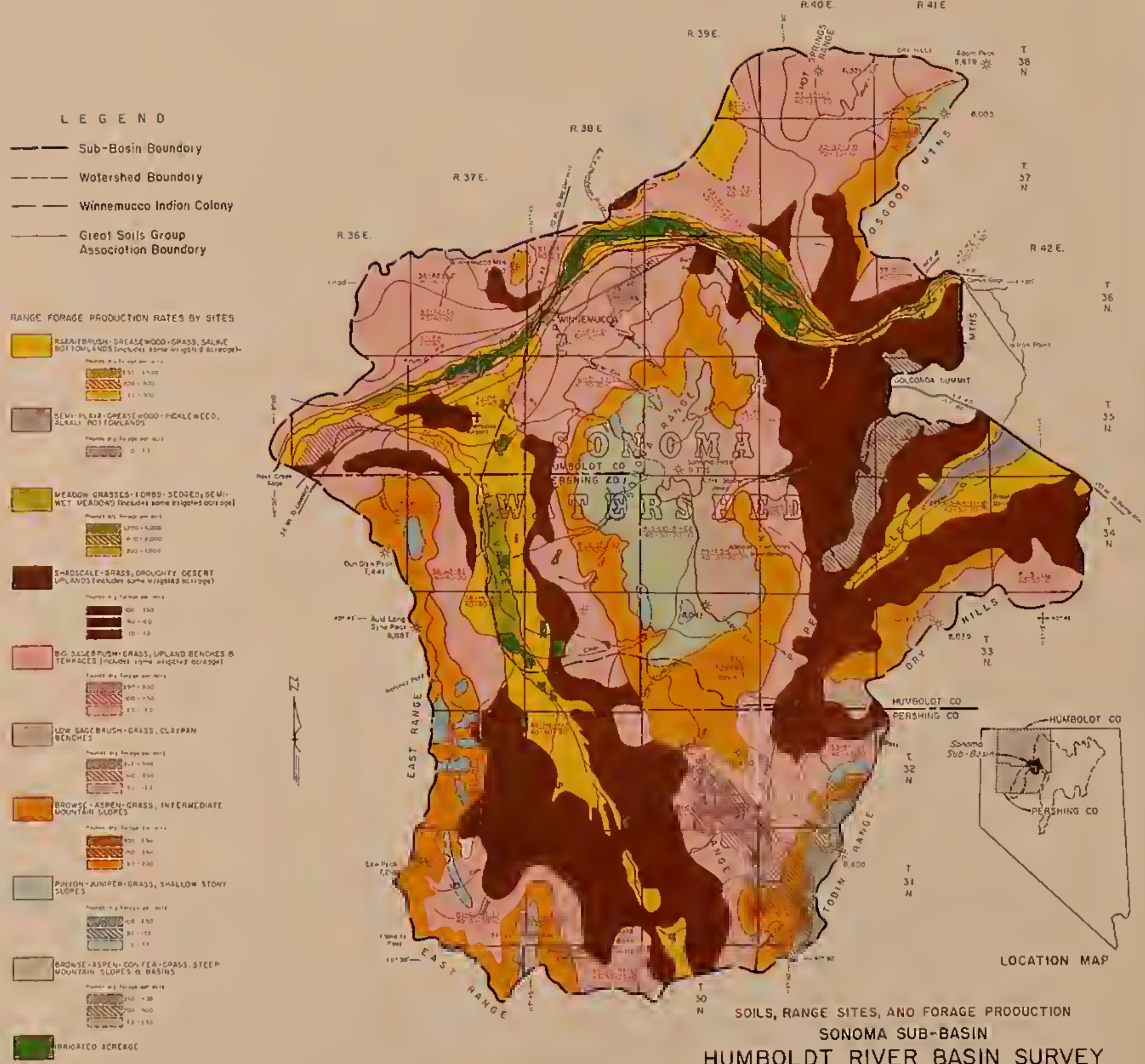

LEGEND
Sub-Basin Boundary
Watershed Boundary
Winnemucca Indian Colony
BR Land purchased by the Bureau of Reclamation for acquisition of water for the Rye Patch Proj.
Private Land
Federal Land
R 36 E.
R 37 E
R 38 E
R 39 E
R 42 E.
WINNEMUCCA
SONOMA
WATERSHED
HUMBOLDT CO
PERSHING CO
GOLCONDA SUMMIT
EAST RANGE
SONOMA RANGE
TOBIN RANGE
DRY HILLS
OSGOOD MTNS
LOCATION MAP
LAND STATUS MAP
SONOMA SUB-BASIN
HUMBOLDT RIVER BASIN SURVEY
HUMBOLDT & PERSHING COUNTIES, NEVADA
MAY 1965
7-P-17884-N



SOILS, RANGE SITES, AND FORAGE PRODUCTION

SONOMA SUB-BASIN

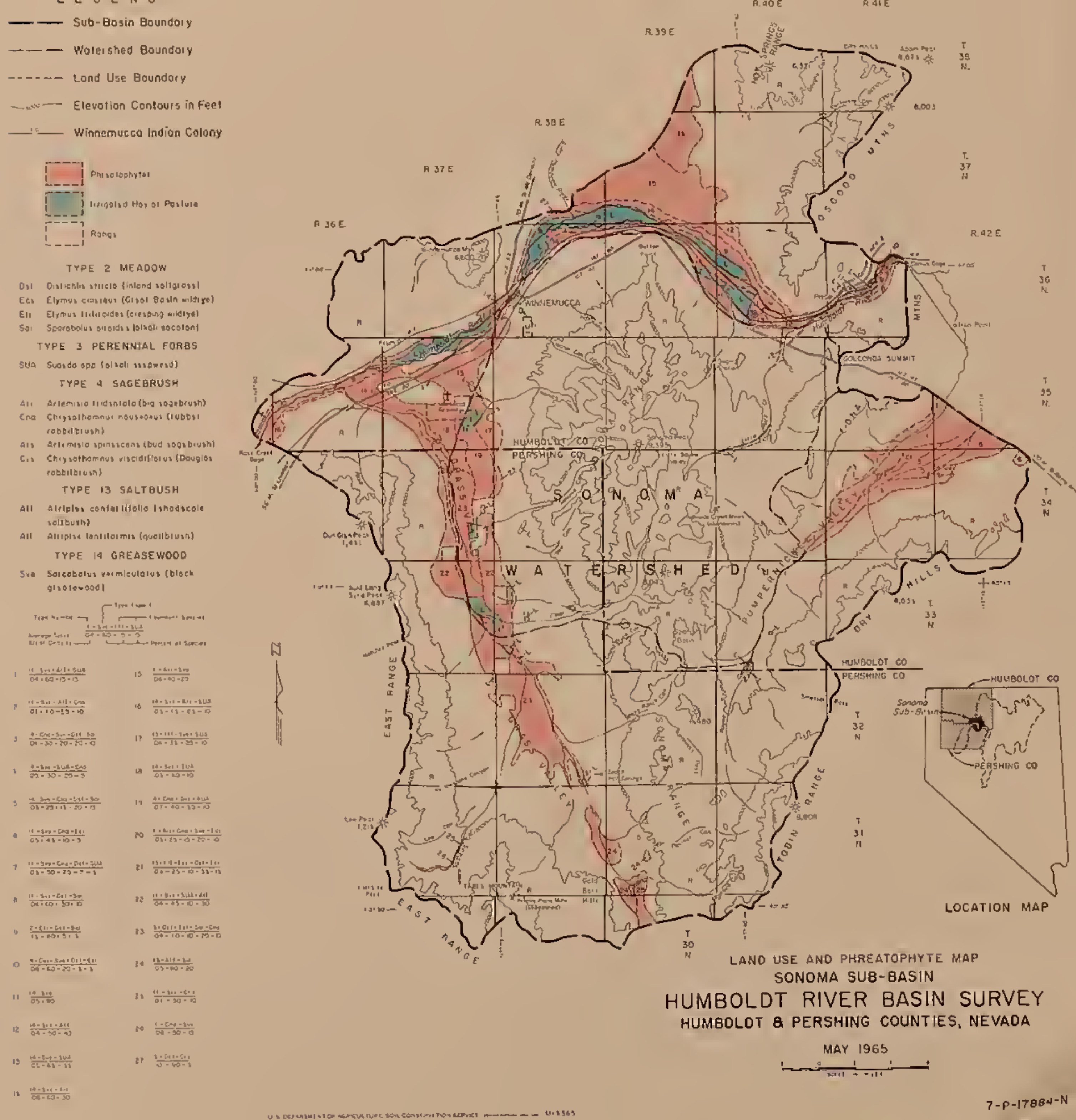
HUMBOLDT RIVER BASIN SURVEY

HUMBOLDT & PERSHING COUNTIES, NEVADA

MAY 1965

U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

7-P-17884-N


LEGEND
Sub-Basin Boundary
Watershed Boundary
Land Use Boundary
Elevation Contours in Feet
Winnemucca Indian Colony
Phreatophytes
Irrigated Hay or Pasture
Range
TYPE 2 MEADOW
Dst Distichlis stricta (inland saltgrass)
Ecs Elymus cinereus (Great Basin wildrye)
Eti Elymus triticoides (creeping wildrye)
Sai Sporobolus airoides (alkali sacaton)
TYPE 3 PERENNIAL FORBS
SUA Suaeda spp (alkali seepweed)
TYPE 4 SAGEBRUSH
Atr Artemisia tridentata (big sagebrush)
Cna Chrysothamnus nauseosus (rubber rabbitbrush)
Ats Artemisia spinescens (bud sagebrush)
Cvs Chrysothamnus viscidiflorus (Douglas rabbitbrush)
TYPE 13 SALTBUSH
Atl Atriplex confertifolia (shadscale saltbush)
Atl Atriplex lentiformis (quailbrush)
TYPE 14 GREASEWOOD
Sve Sarcobatus vermiculatus (black greasewood)
R 36 E
R 37 E
R 38 E
R 39 E
R 40 E
R 41 E
R 42 E
WINNEMUCCA
HUMBOLDT CO
PERSHING CO
SONOMA
WATERSHED
OSGOOD MTNS
GOLCONDA SUMMIT
EAST RANGE
SONOMA RANGE
TOBIN RANGE
DRY HILLS
LOCATION MAP
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LAND USE AND PHREATOPHYTE MAP
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